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CONTENTS AND INDEX.

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CONTENTS:

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*KNOWLEDGE AND PRACTICE.**

The honor of delivering the address upon this occasion is great; the responsibility of appearing as the successor of the distinguished men who have addressed you in previous years is also great, yet, as I thank you for your generous welcome, I feel, most of all, the pleasure of being the guest of Yale. To a Harvard man an honor bestowed by Yale has a special and very pleasant value.

Yale and Harvard have been working together for two centuries; their aims have always been similar; their developments have been parallel, and they have long sought one another for those friendly contests, intellectual and athletic, which yearly renew the close bonds between the two universities. I hope that their experience has been mutually helpful, for I am sure at least that Harvard has often learned from Yale, and they both have the same problems to solve if necessary.

Just at present there is a whole series of urgent problems in medical education before both institutions, and I shall, with your permission, try now to contribute to the discussion of some of those problems. You, who are upon the eve of graduation, know that you have received a far better preparation for the practice of medicine than was possible for any one to obtain a generation ago. You owe this advantage to the constant recognition of the possibility of improvement in medical education, and you should carry forth the feeling that it is now your duty to promote further progress in the organization and methods of medical schools. It is, therefore, eminently fitting

* Yale University Medical Commencement Address, June 29, 1899.

to the occasion to examine some of the possible ways of advancing medicine. Permit me, then, to lay before you certain suggestions which my experience as a teacher of medical science has brought to my mind. Others can deal far better than I with the strictly clinical problems. In the course of my address I shall have to emphasize certain limitations which are detrimental to medicine and which progress must step over. We must, however, not forget that criticism in itself is of slight value, unless it guides us to possibilities of progress. This interpretation of criticism should preside throughout our discussion.

The physician's work is not a trade in which he can perfect his skill once for all, but a profession based on learning, without interruption, new facts, new methods and even totally new ideas. The conversion of a student into a *medicinæ doctor* is too commonly looked upon as the end of the period of learning, but the student ought rather to look upon it as a certificate that he is at last qualified to learn, with reasonable efficiency, and, above all, with reasonable security as to his learning aright. Routine in medical practice is professional degradation.

There is one problem which we must all meet, the solution of which we cannot shirk, except by the supreme and final cowardice of suicide. So long as we live we are giving our solution to this problem, the problem of conduct, solving it equally by what we do and what we do not do, by our activities and our inhibitions. Some men give a mean solution, a mere summing-up of whims and accidents ; others give the bad solution of selfishness, passion or vice. The great object of our universities is to aid men to reach a noble solution under the dominion of wisdom and uprightness. You will often hear the assertion that our colleges have one of their most important functions in the building-up of character. The college of which this is not true deserves no students. But with this assertion is sometimes coupled the implication that the professional and scientific schools do not exert as much influence as the college on character. Such an implication may be excused to ignorance, but that would be a sorry medical school of which it were true. A medical school must develop character as well as mind, or else fail to produce graduates who can solve their problems of professional as well as of personal conduct.

Conduct presents to us a fourfold aspect : a physical, a social, an æsthetic and an intellectual. The physical aspect is that which the physicans chiefly deal with, it being their work to regulate understandingly the doings of the body. To fit men for this work is the object of medical education. How to acheive this object I will ask you to discuss with me presently. The social aspect of conduct, the relation of what the individual does in its bearing upon others, has endless phases, but there is no profession in which the personal social relations are so much a part of the necessary professional equipment as in the profession of medicine. The practitioner must abound in conscientiousness, honor and tact, and it is a natural consequence that there exists a code of ethics wherever physicians have formed associations. The æsthetic side of conduct, the securing of beautiful things because they are beautiful, concerns the medical man less, although he pursues the art of healing, and healing is really an art, a very fine art, as well as a science. The intellectual aspect of his own conduct is to the physician sovereign over all the rest. Medicine is distinctively an intellectual occupation. Let this bare schedule suffice to emphasize the fact that the physician more than men in most occupations needs a varied endowment, a broad foundation of character and a liberal education. I think that physicians as a class are distinguished

by the breadth of their sympathies and by their manifold interests. This is the natural consequence of their having to deal constantly, for themselves and for others, with the problem of conduct in all its aspects.

In contrast with all these liberal qualities we find too commonly an attitude toward pure science and toward biology which seems to me much the reverse of liberal. I must go farther and say frankly that this prevailing attitude marks an important limitation of the medical profession, and that it points to defects in our system of medical education. Courageous acknowledgment of our needs is the first step towards satisfying them. I shall now endeavor to convince you that the criticism made is not only just, but that it discovers the way for vast educational progress, and I trust that in the end you will feel the point of view to be both friendly and helpful.

The mental attitude, the modification of which seems to me so desirable, reveals itself by distrust of pure science and by ignoring the relations of medicine to biology. Let us consider the case in its two phases.

First, then, as to science. To the academic proposition that science is the basis of medicine every one would assent, but, none the less, a great many practitioners still draw a sharp line between 'theoretical' and 'practical' doctors. Those who think this distinction are, of course, 'practical' men, and they are guilty of a triple error: first, that scientific is theoretical; second, that theoretical is impractical; third, that practical is superior to theoretical. This misconception still exerts influence, although it is certainly waning. Make it your part to hasten its extermination.

The feeling against medical science as impractical has been very strong in America, probably stronger than anywhere else in the world. Our colonial ancestors had to help themselves in every thing, and we have apparently inherited the belief that any way is the best way, and that expert capacity is a *luxe de trop*. We must remember, too, that medicine grew up as an art, not as a science, and that such progress as it made until this century was well along was chiefly by empirical experience.

It is only for about fifty years that research, properly so-called, has been an important factor, only about twenty-five years that it has been the leading factor in medical progress. It is, therefore, not to be wondered at that older practitioners, especially if without intercourse with university centers, are unconscious of the full measure of the change. The change is momentous, yet it has been so rapid that it falls largely within the period of the medical experience of many here present. Another curious factor in establishing and maintaining the notion that science is unpractical was the conventional idea of a scientific man, which prevailed even within thirty years, and which I can perfectly recall as a half-accepted standard when I decided to choose science for my career. This conventional scientist was a man past middle life, who wore an unfashionable hat, large spectacles, ill-fitting clothes, who was more or less absorbed in abstruse ideas and in studies of no practical use, really learned, very absent-minded and more rather than less in need of being looked after by somebody with common sense. It was almost necessary for a scientific man to cultivate absence of mind in order to sustain his reputation. It would certainly be an interesting study to trace the history of this phase of American science, since it was a phase, though a quaint one, of the eternal assertion that the best science is independent of immediate utilitarian consideration.

Resuming the direct course of our thought, we may say that on the one side the notion that 'scientific' is synonymous with 'unpractical' has its historical justification, but

on the other side it is now only a survival, an unjust opinion, a prejudice to be surrendered unconditionally. The prejudice against science has been very influential. Even fifteen years ago a young physician could not afford, no matter how much leisure he might have, to work in a scientific laboratory, because he would have been stigmatized as 'theoretical' and patients would have been turned away. I speak by chapter and verse, for I know many instances of young men beginning good research work, and then soon being compelled to give it up, by the force of professional opinion. We now know that this opinion was in large part a prejudice, the disappearance of which removes the final barrier across the entrance to the new era, which it has taken our entire century to open. The establishment of science in its rightful place has been going on steadily for a long period, but within five years it has rushed towards its culmination. We owe the complete medical recognition of the value of pure science to Bacteriology. Listen to the following dates. In 1879 Koch introduced the method of solid cultures; in 1882 he published his monograph announcing the discovery of the bacillus of tuberculosis. In 1884 came Löffler's paper on the bacillus of diphtheria. In 1891 appeared Councilman's account of the amœba of dysentery. At the International Medical Congress in 1893 Roux described the use of antitoxine in diphtheria, and about the same time McFadyean secured recognition for the value of mallein in the diagnosis of glanders. In 1896 came Vidal's reaction for identifying the germs of typhoid fever.

Here were results entirely beyond the ken of the practitioner, laboratory discoveries which he could only accept but not verify for himself, although in their application he could furnish dramatic proof of their value. No wonder that science now receives her meed.

It is safe to prophesy that hereafter medical science and medical practice will be both more sharply divided and more intimately correlated than heretofore. We already note that the experience of the clinician can rarely do more than effect improvements in methods, while the new principles come from the laboratories. The clinician may ask good questions, but he now depends so much upon the scientific worker for his answers that there is a sudden demand for laboratories in connection with every hospital. This demand marks the final unconditional surrender of the practitioner to pure science. The end is not yet. It is not enough that the value of scientific research is at last acknowledged, but the practitioner must also adopt the scientific method for himself.

What do I mean by the scientific method? There is much vague misconception concerning it, based upon the erroneous assumption that it is a peculiar method belonging to science. It is really only the right method of ascertaining the objective truth. It is in the classic words of von Baer, *Beobachtung und Reflexion*, observation and reasoning. The student at the microscope looking at nuclei and protoplasm and deriving therefrom a correct conception of the nature of a cell uses the scientific method, and he uses the scientific method again when he observes the symptoms of patients and reasons therefrom. There is nothing to distinguish the scientific method from the methods of every-day life except its precision. It is not a difference in kind or quality, but a quantitative difference, which marks the work of the true scientist and gives it validity. The definition of the scientific method seems simplicity itself, nevertheless it takes years upon years of the severest discipline to give even a partial mastery of the method, because to observe correctly and reason correctly are the most difficult accomplishments a man can

strive for, and he who acquires them to a high degree is a great man; such were Helmholtz, Darwin, Newton and a few others out of all time. The two grades of observation and reasoning must be distinguished, the lower repetitive grade and the higher original grade. Many a person of ability may be taught to see and understand that which has been seen and understood before. Such persons in medicine can make correct diagnoses of known diseases, but in the presence of the new unknown they fail. Such persons in science may do good work as followers, not leaders—privates, not generals. To the few are accorded the privileges of the higher grade, right sight and right thought as they invade the unknown. The training in exact science does more than any other discipline to elevate those who have sufficiently great gifts into this highest intellectual grade. We say, therefore, unhesitatingly that severe scientific education is the principal addition we ought to make to our medical curriculum. So I come back to my opening assertion: We must teach how to learn, and how to learn from the unknown.

If we admit the principle that science should have a more influential place than at present we must decide in what way that place can be provided. It is, I think, undesirable to lengthen the medical course beyond the four years now required; it is undesirable to omit any of the subjects now offered, and it is equally undesirable to enlarge greatly the fundamental scientific courses in anatomy, physiology, pathology, etc. We seem surrounded by impassable walls, but there are two considerations which may guide us. On the one hand is the enormous growth of medical knowledge, which is beyond the power of any single student to master, so that some choice must be made for him or by him. On the other hand the science we are now seeking a place for is not that which is basal, but that which is to perfect and end the whole training; it is to be the top, not the foundation. Clearly, then, the way out is to introduce the elective system on a large scale into the fourth and perhaps third year. Make a series of these electives for advanced work in scientific subjects, such as anatomy, embryology, physiology, pathology, pharmacology, bacteriology. As you know, this solution has been tried, and with most encouraging results. May we not look forward to its becoming the universal method throughout America?

As regards the elective system I follow Dr. Henry P. Bowditch in believing that it should be greatly extended, and that the required studies in medicine should be reduced to the minimum, and numerous electives provided for every year of study. These proposed electives may be in subjects already taught and also may provide courses not usually offered, such, for example, as examination of the blood, pathological chemistry and psychology in its medical aspects. The elective system is the educational answer to the tendency toward specialization in practice, and I believe that we have no choice as to its adoption.

We pass on to the consideration of the second phase of the case which we are debating. It will probably need a much longer and more sustained effort to bring about a correct recognition of the relations of medicine to biology than is needed to win recognition for science at large.

Medicine is one department of applied biology, just as dyeing is one department of applied chemistry, or electric lighting a department of applied physics. Now if a man wishes to become an expert dyer or electrician he studies chemistry as a whole and physics as a whole, but the would-be physician begins at once with human anatomy and human physiology, and probably to the end of his days never discovers that he has no conception whatever of biological

science. Carl Semper used to say, *die Mediziner sind lauter verdorbene Zoologen*—the medical men are all spoilt zoologists—and the saying still remains only too nearly true.

The first question is : What place shall be given to biology in medical education ? In order to answer this question we must remember that biology should here serve a twofold purpose, that of making the beginning so as to lay the proper foundation for further study and that of inculcating the value of the comparative method.

The fundamental principles of biology ought to be taught to every student of medicine before he is allowed to study medical anatomy or physiology. This great reform will surely come about, and has, in fact, been already effected by one important university, which has made biology a requirement for admission to its medical school. Or perhaps the necessary time can be secured, after the student has entered the medical school, by lessening the number of hours now required for anatomy. That far more time is usually devoted to anatomy than is advantageous to the student I am thoroughly convinced. Formerly, when gross anatomy gave the student almost his only training in exact scientific observation, the subject had a pedagogic value, which it has since lost in very large measure, because histology, experimental physiology, bacteriology and pathology offer far better discipline of the observational power than anatomy alone can supply.

It must be further remembered that a large part of anatomy is to the student sheer memorizing and without intellectual value. Finally, we all know that a large proportion of the facts of descriptive anatomy are speedily forgotten after the examinations are past, and that the practitioner finds no occasion to recall them. A study which occupies so many hours as to exclude other valuable forms of mental training and imparts much information not of practical value may well be abbreviated. On the other hand, a thorough course in descriptive anatomy, exclusive of histology and surgical anatomy, must always be indispensable. The only question is concerning the proportionate division of time with the other studies, which within recent years have become equally indispensable.

My second point is the inculcation of the value of the comparative method, to which the development of biological science is mainly due. Life presents itself in an immense variety of species, and the vital phenomena assume a characteristic manifestation in each species. It is by comparing the structure and functions that we are able to distinguish the fundamental and essential part of the phenomena from that which is secondary, and thus we gradually reach those generalizations which alone constitute true science. A detail is a grain of earth, useless for building until it is compacted with many other grains into a useful shape, which, hardened, like a brick, in the furnace of thought, can be added to the temple of knowledge. Now, since medical interest centers in man, medical investigators have cared little for comparative research, and have often failed to grasp the problems with which they dealt. Many an able physician, when he studies, say the physiology or pathology of a dog, a guniea pig or a frog, honestly thinks that he is studying comparative physiology or comparative pathology, although he is really doing nothing of the kind. He is studying, perhaps, gastric digestion or the hypertrophic degeneration of the liver; he seeks to understand the process in the one organ or the other, and the stomach is to him the stomach, the liver the liver. He may note the differences between one animal and another if they are marked, but he does not attempt to determine the process in the carnivora, the rodents and the amphibia, see what is common to them all, and what is special modi-

fication for each of these groups. One has only to read any accepted text-book of physiology or pathology to see that it is absolutely true that the narrow or anthropomorphic view is the typical medical view. The medical man may learn from the zoologist and botanist, who have depended chiefly upon the comparative method for their most important results. Science cannot be hampered by any conventional restriction; it must be free to turn in every direction in which a discovery is possible. Now, medicine places a conventional restriction around the medical sciences, for by custom and precedent it orders that, even though the actual investigation be upon some animal, it shall be regarded solely as elucidating human structure and human function—in other words, the interpretation must be anthropomorphic. This convention has led to some strange absurdities, of which I shall mention only one; the microscopic structure of the kidney has been investigated chiefly in animals, notably the dog and rabbit; all the text-books of anatomy and histology known to me, with a solitary exception, describe the structure of the human kidney in accordance with the observations on these animals; but, as the human kidney really differs in many important respects from that of the dog and the rabbit, the structure of the *human kidney* still remains generally unknown. This error has been perpetuated through fifty years. Since zoologists are habituated to the comparative method, would it not be wholly impossible for a blunder of this kind to be kept up in their work?

I am so thoroughly convinced of the value of the comparative method, of the absolute necessity of its adoption in medical research, that I look forward to its acceptance as the greatest advance in medicine which our time will know. Methods of obtaining knowledge are the means of progress. Remember how much anatomy owes to the method of human dissection; how much pathology owes to the method of staining microscopical preparations; how much surgery owes to the method of antisepsis; how much bacteriology owes to the method of artificial cultures. These are, however, merely technical methods, but that which I am now advocating is a mental method, a way of successful thinking, a process of right reasoning, far more comprehensive than any technical method; and, if we accept it, we can explore vast regions of knowledge, the very possibilities of which we barely recognize now. Let it encourage us that the comparative anatomist and comparative embryologist are already well advanced along the path which the physiologist and pathologist must now learn to follow.

Medicine is destined to become comparative, because it must advance. The wise action for us is to facilitate that advance, and thus the question becomes: What shall we do practically to establish and promote comparative medicine? If we agree that our aim is to secure the very best kind of research in medical science the practical answer is clear: We must provide post-graduate instruction, with courses thoroughly systematized and correlated, covering at least two years, to qualify men to become professional investigators in the comparative sciences of morphology, physiology, pathology, bacteriology, preventive medicine, etc. It is remarkable that these sciences have never reached a university standing. It ought now to be secured. If a young man wishes to make a scientific career, if his interest is chemistry, physics, botany or zoology, he is received at one of our universities started upon a well-planned course properly systematized, he gives for two or three years most of his strength to his main subject, but he follows probably two cognate subjects as minor studies, and at the end of his time, if successful in his

work, he receives a degree, which attests his proficiency in his special science. Should the same young man elect to study one of the medical sciences, physiology, pathology or bacteriology, no university will give him corresponding recognition. The utmost he can find is opportunity for advanced work in his special subject, but with no university guidance, no plan of correlated studies, and he can look forward to no degree nor even to a certificate from the university. Must we not admit that here is a great omission in our university organization? Is it not a pressing duty to repair this omission? Surely to put these questions is to assent to them.

We are thus brought to the conclusion that, though the primary function of our medical schools is to educate practitioners of medicine, yet they ought to assume now the further and higher function of training medical investigators. To succeed in this the medical laboratories must be expanded, their resources enlarged and the staff increased, so that the officers will have time and means for both researches of their own and for guiding the researches of advanced students. Yale has been teaching a needed lesson, for her laboratory of physiological chemistry has shown what splendid results ensue when one of the so-called medical sciences is set free and allowed to develop as the peer of other sciences. Untrammel them, strike off their bonds, and comparative morphology, comparative physiology and comparative pathology will develop and add to the good work and glory of your alma mater as physiological chemistry has already done.

Laboratories are of very recent origin; seventy-five years ago there were none. There are but few laboratories which have stood for as much as twenty-five years. Our experience with them has not been long, but we have learned two things concerning them: that they are absolutely indispensable and that they are very costly, so costly that a university has become an enterprise of great financial magnitude. Formerly a college with an endowment of a million dollars was wealthy; at present a university with three thousand students and twenty millions dollars has to practice rigid economy to keep running properly. We who are at work for universities are painfully conscious of needs, and it seems to me a common duty for us all to make known to the public, upon whose generosity American higher education depends, the true scale of those needs.

The requirements of comparative medicine call for more changes than we have yet mentioned. The very word comparative implies that animals shall be included in the range of study. It means that not only shall provision be made for investigating the structure of animals and for physiological experiments, but also for the observation and treatment of sick animals, or, in other words, there ought to be a veterinary hospital in intimate association with the school of human medicine. Such a hospital would increase the range of experience and contribute a broadening impulse to all medical work. It is, I believe, quite a new project to consolidate the interests of veterinary and human medicine, but it is, by the initiative of President Eliot, under actual consideration at Harvard, and will, if carried out, be an epoch-making advance. It will be a public and effectual assertion of the solidarity of all medical science and of all forms of medical practice. It will be a boon to pathological and clinical research, for it will offer opportunities for the study not only of diseases specially characteristic of animals (such as the distemper of dogs), but also of those diseases common to man and animals. We are thus brought round to still another aspect of the beneficence of medical consolidation, the future development of preventive medicine.

Preventive medicine is a term of recent currency. We have come to think more about it in consequence of the growth of our knowledge of disease-germs, which has led to the hope that we can control germs, so as to prevent or at least greatly diminish the danger of infections. Moreover, serum-therapy, the anti-toxin treatment and the discovery of the influence of the thyroid and suprarenal extracts have made us familiar with the conception that profound influences may be exerted by quantitatively slight changes in the chemical conditions within the body. Here are two illustrations of ways in which disease may be impeded. It is a field which might be considered a part of that of hygiene, but it is logically distinct. To stop disease is not the same as preserving health. Now, we are all agreed that prevention is a rapidly increasing part of medical practice, and, since many diseases, like tuberculosis, typhoid fever or the bubonic plague, are spread by animals, it follows that we must look upon the study of diseases of animals as an integral and indispensable portion of preventive medicine. A hospital is as necessary for the observation and treatment of sick animals as of sick men.

Most of us, I am sure, anticipate in the near future a magnificent development of preventive medicine. One of the best means to promote the fulfilment of these anticipations is to bring the veterinary hospital into close and intimate union with the medical school.

The veterinary profession, like the medical, is raising its standards rapidly, and we can only wish success to these efforts, for not only does the case of sick animals require the highest skill, but also the advance of veterinary science calls for the best scientific ability. If veterinary schools are brought, by means of their hospitals, into close touch with medical schools it will hasten the elevation of the veterinary profession, and will bring nearer the time we all shall say that the veterinary school is as worthy a place in the university organization as is the medical school. When that time comes, as the foundations of medicine will be broad and wisely laid, so will the superstructure be stable.

As for the fear, which I heard expressed at a recent medical meeting, that doctors are destroying their own means of livelihood, because preventive medicine is limiting the supply of diseases to be cured, I may say that fear has not limited the eagerness of physicians to increase prevention. On the other hand, there is the consoling hypothesis that there are likely to remain many diseases, especially those which are difficult to identify and to treat and also those of sporadic occurrence, which will keep practitioners busy in the future. As the time is passing away when a large part of active practice consisted in cases of typhoid, diphtheria and other preventable diseases, rarer forms of illness will be more thoroughly studied, and, as they will require a higher skill, the future physician will seek a better training than we can offer to-day. Thus one of the indirect results of the advance of preventive medicine is to raise the standard of medical education.

I have said enough to indicate the far-reaching consequences of the conviction, which I hold and hope you hold, that the comparative method of biology is to direct the development of medical practice. The adoption of the comparative method will revolutionize both medical teaching and the organization of our medical schools.

We must now turn our attention to certain other questions of medical education. During the past year there has been going on a very widespread discussion in this country over the curriculum for medical students, and the prospect of consequent improvement is encouraging. I cannot venture upon attempting more than the

presentation of certain definite ideas which have formed themselves in my own mind as the result of the late discussion, and must leave to others a more comprehensive treatment.

Foremost in importance is the idea that the number of lectures is too great, probably, in every course given, and that the laboratory work and the personal clinical work occupy too small a proportion of the student's time. The practical work is the instructive work; it is the source of real knowledge. The actual direct contact with the objects and with the phenomena *is* knowledge. The very best that can be said of a lecture or a book is that it describes well the knowledge which someone possesses. There is no knowledge in books, and that motto ought to be inscribed over the library door. A book or lecture can serve only to assist a man to acquire knowledge with lessened loss of time. Knowledge lives in the laboratory; when it is dead we bury it, decently, in a book. Now real knowledge is what the medical practitioner needs, the personal mental image of things seen, felt and heard; he needs to establish a short circuit between sensations and the true psychic concept, but if you train him to interpolate books you are likely to make the circuit so long that there will be no true concept at the end of such a resistance path. Our greatest discovery in scientific teaching is the discovery of the value of the laboratory and its immeasurable superiority to the book in itself. A lecture is a spoken book, and must, therefore, also yield to the superior claims of first-hand knowledge.

It is the corollary of the value of laboratory instruction that the examinations should be practical, or, in other words, that the conventional written examination should be given up. All the clinical work is, of course, to be classed as laboratory instruction, and the time ought not to be far distant when students will be required to make diagnoses from patients directly as the test of their proficiency. No one who has examined students in both ways is likely to question the superiority of the practical examination over the written. It is a real test of real knowledge, and is fair to the student for that very reason, and it avoids the two defects of the old-fashioned examination paper: first, the defect of testing memory rather than mental power; second, the defect of offering rewards for cramming. A practical examination has the great advantage of emphasizing to every student the necessity of personal familiarity with the objective basis of his studies.

A second important idea is that the requirements for a medical degree shall no longer be uniform for all candidates. That this idea will be adopted is necessarily the belief of every one who advocates the elective system.

A new arrangement of studies has been adopted by the Faculty of the Harvard Medical to go into effect next year. It is the result of prolonged careful debate. It is based upon three leading principles, concentration, correlation and sequence of subjects. The system consists in a division of studies by half years and by half days within the half year. The elementary anatomy will be confined to the first term of the first year, but will occupy half of every day; the other half of every day will be occupied by histology, embryology and a special course on the brain. In the second term a similar system will be followed, half a day for physiology and half a day for physiological chemistry. In the first term of the second year this simple dual plan is pursued with pathology and bacteriology; beyond this the arrangement is more elaborate, and for the third and fourth years is not yet fixed.

The new plan is, of course, an experiment, but is fully expected to prove a successful one, because it will make the work

of the student easier by concentrating his thoughts upon one subject instead of dissipating his attention among many subjects. If a man wishes to accomplish intellectual labor he seeks instinctively to apply himself wholly to that one task until it is completed. The capacity for sustained effort is the power by which the man surpasses the child. The child needs constant change and variety, and the system, which we have had in our school, of running from one lecture to another and from one laboratory to another, appears to many of us more suitable for school children than for young men studying medicine, and we expect, therefore, the new plan of studies to be justified by its results.

Here we must pause, although we have merely touched upon general principles and looked at a few details as illustrations. It seems to me that the whole problem of medical education is just now one of the most interesting and important ever presented in the history of American universities. If I have stimulated your interest in it I am rewarded.

Before I close I will venture to address to those of you who are to-morrow to receive your medical degrees a few words upon the deeper signification of your profession. This is not the time to enter into a discussion of the assumed antagonism between practical science and Christian faith. Each year brings the two into closer and more helpful relationship and increases their mutual understanding. The dignified agnosticism of Huxley and the lofty spiritualism of Brooks meet in the common conviction that the growth and development of man to a higher and better physical and spiritual life is alone what makes existence worthy.

We are living in an epoch of great scientific discovery and of consequent material progress, which among its many results includes numerous new facilities for intercourse between nations. In contemplating these facilities one recalls how great a part the free intercourse under the great Roman Empire played in the first spread of Christianity, so that one involuntarily asks: Is not science now aiding the same cause in a similar way? Science does more. By its steadfast pursuit of truth; by its broad-minded ability to acknowledge the truth whatever found; by its freedom from narrow dogmatism on the one hand, and from ignorant materialism on the other, science can do a noble work in the great battle between good and evil in the world.

The antagonism of science and religion is unreal. Our intellectual Quixotes take it for one of their windmills, but I very much doubt if it be more than the phantom of a windmill. When you, young men, begin your life's campaign, fight real foes, be blind to threatening phantoms and deaf to their noisy shibboleths. Attack real difficulties. Remember always that as physicians you will have to help others, and that it will be peculiarly your obligation to uphold the standard of faithful service and to defend what I may call the creed of science: that the advancement of knowledge is a duty because it serves mankind. Faithful scientific research is Christian service.

CHARLES SEDGWICK MINOT.

LORD KELVIN'S ADDRESS ON THE AGE OF THE EARTH AS AN ABODE FITTED FOR LIFE.

II.

A THIRD line of argument relative to the habitable era of the earth is drawn from the theoretical age of the sun. After stating the probability that, if sunlight was ready, the earth was ready both for vegetable and animal life within a century, or at least a few centuries, after the consolidation of the earth's surface, Lord Kelvin inquires whether the sun was ready, and re-

plies:* "The well-founded dynamical theory of the sun's heat carefully worked out and discussed by Helmholtz, Newcomb and myself, says No if the consolidation of the earth took place as long [ago] as 50 million years; the solid earth must in that case have waited 20 or 50 [30?] million years for the sun to be anything nearly as warm as he is at present. If the consolidation of the earth was finished 20 or 25 million years ago the sun was probably ready, though probably not then quite so warm as at present, yet warm enough to support some kind of vegetable and animal life on the earth." Here is an unqualified assumption of the completeness of the Helmholtzian theory of the sun's heat and of the correctness of deductions drawn from it in relation to the past life of the sun. There is the further assumption, by implication, that no other essential factors entered into the problem. Are these assumptions beyond legitimate question? In the first place, without questioning its *correctness*, is it safe to assume that the Helmholtzian hypothesis of the heat of the sun is a *complete* theory? Is present knowledge relative to the behavior of matter under such extraordinary conditions as obtain in the interior of the sun sufficiently exhaustive to warrant the assertion that no unrecognized sources of heat reside there? What the internal constitution of the atoms may be is yet an open question. It is not improbable that they are complex organizations and the seats of enormous energies. Certainly, no careful chemist would affirm either that the atoms are really elementary or that there may not be locked up in them energies of the first order of magnitude. No cautious chemist would probably venture to assert that the component atomecules, to use a convenient phrase, may not have energies of rotation, revolution, position and be otherwise comparable in kind and proportion to those of a planetary system. Nor would he probably feel prepared to affirm or deny that the extraordinary conditions which reside in the center of the sun may not set free a portion of this energy. The Helmholtzian theory takes no cognizance of latent and occluded energies of an atomic or ultra-atomic nature. A ton of ice and a ton of water at a like distance from the center of the system are accounted equivalents, though they differ notably in the total sum of their energies. The familiar latent and chemical energies are, to be sure, negligible quantities compared with the enormous resources that reside in gravitation. But is it quite safe to assume that this is true of the unknown energies wrapped up in the internal constitution of the atoms? Are we quite sure we have yet probed the bottom of the sources of energy and are able to measure even roughly its sum-total?

*SCIENCE, May 19, 1899, p. 711.

There are some things hereabouts in the instruction we receive that puzzle us with our geological limitations:

1. We are taught that there is a certain critical temperature for every substance above which it takes the gaseous form, and no amount of pressure can reduce it to the liquid or solid state.

2. We are taught that gases are compressible to an indefinite extent provided their temperatures be above the critical point.

3. We are told the temperature of the interior of the sun is probably above the critical temperature of any known substance, and hence that all the material of the interior of the sun is probably gaseous.

4. We are taught that so long as the substances of the sun remain in the gaseous condition the temperature of the sun must rise from increased self-compression. It cannot, therefore, fall to the critical temperature of the component substances, and must, therefore, continue in the gaseous state and grow hotter and hotter.

5. We are taught that gravity varies inversely as the square of the distance. As the distance between any two particles is halved, their mutual attraction is raised fourfold. Perpetual halving would cause the attraction to mount up toward infinity.

In the sun, then, there seems to be this interesting combination : (1) a gaseous mass already above the critical temperature growing hotter and hotter by self-compression and bound to grow hotter and hotter so long as it remains a gas ; and it is bound to remain a gas until it falls below the critical temperature, which it cannot do while it continues to grow hotter; (2) a gravity that increases four-fold with every halving of distance and that is bound to increase so long as concentration continues, and concentration must continue while the substance is a gas and the gravitative pressure increases.

What is the logical outcome of this kind of logic and this sort of a combination ? A geologist begins to grow dizzy contemplating such thermal possibilities. Why should not atoms, atomecules, and whatever else lies below, one after another have their energies squeezed out of them ; and the outer regions be heated and lighted for an unknowable period at their expense ?

There was a time when the chemical theory of the sun's heat was fairly satisfactory to the scientists of the day, but its inadequacy appeared in time. There followed a period in which the meteoroidal theory of the sun's origin was deemed adequate, but its defects soon became apparent. There has followed the contractional theory, the validity of which is perhaps not less questioned now than was the validity of the chemical and meteoroidal hypotheses in their day of acceptance, but, judging from the past, it may easily appear in the future that the Helmholtzian theory is inadequate in some measure not unlike its predecessors.

But assuming, as we are wont to do, that the limits of our present knowledge are a definition of the facts, has the evolution of the sun been worked out with such definiteness and precision as to give a determinate and specific history of its thermal stages from beginning to end? It is one thing to tell us, on the basis of the contractional theory, that the total amount of thermal energy originally potential in the system is only equal to so many million times the present annual output, but it is quite a different thing to give a specific statement of the *actual time occupied by the sun in the evolution and discharge of this amount of heat* and to define its successive stages. It is with this actual history that we are specially concerned. The distribution of the computed heat in time may have been such hypothetically as to shorten the period of its expenditure not simply to 20 or 25 millions of years, as indicated by Lord Kelvin, but to four or six millions of years as deduced by Ritter.* On the other hand, the dealing-out of this amount of heat may hypothetically have occupied a period many times the 20 or 25 million years postulated. It seems altogether necessary to determine specifically *the distribution of the heat in time* before any approach to a satisfactory application to geological history can be made. The period of 20 or 25 million years named can have little moral guiding force until this problem is solved. But the literature of the subject shows an almost complete neglect of this consideration. While certain of the physicists and astronomers have been instructing us '*e superiore loco*,' they seem, with very rare exceptions, to have overlooked this vital factor in the case. Even in computing the sum-total of heat they have, for the most part, heretofore neglected the central condensation of the sun and in their computations have sub-

* *Astrophysical Journal*, December, 1898 ; *Journal of Geology*, p. 93, No. 1, Vol. VII., 1899.

stituted a convenient homogeneity. This is recognized in a more recent number of Science (May 26) in the article by Dr. See, in which he offers a correction which involves an extension of the previously assigned output (18 million times the present annual radiation) to about 32 million times the annual radiation. But even in making this correction he neglects to consider the distribution of this heat in time, and leaves upon the reader the impression that the life-history of the earth was limited to 32 million years. Assuming the correctness of his computations, the past thermal discharge of the sun is merely limited to 32 million times the present annual expenditure. For aught that appears to the contrary, the actual output of this heat may have been spread over any assignable number of years. It is obvious upon consideration that a certain distribution of this past heat would favor longevity of life upon the earth, provided it could exist with a more limited heat supply than the sun is now yielding. On the other hand, it is equally evident that if the supply be distributed in certain other ways, either in the nature of excessive prolongation or of excessive concentration, the life era will be shortened. Doubtless the admonitory physicists have assumed that it was sufficient for the gross purposes of restraining geologists within due limits to determine the total amount of heat without assiduously considering the actual facts relative to its distribution, but some of us are unwilling to accept this loose method of dealing with the problem, since there are resources of application of which our physical friends have perhaps not taken cognizance. For example:

1. If at a certain stage in the evolution of the sun it occupied essentially all the space within the earth's orbit, and was giving forth one-half as much heat per year as now, it would possibly have sufficed for the needs of life upon the earth essentially as well as at present, without the assumption of any change in the constitution of the earth or of its atmosphere. For, on this supposition, approximately one-half of the space into which the earth radiated its heat would be blanketed by the sun and the heat thrown forth from the earth would be measurably caught and returned, and hence the loss of heat by radiation from the surface of the earth would have been reduced.

2. If, at the same time, we suppose that the material now concentrated in the outer planets was dispersed in a broad nebulous or meteoric belt mantling the heavens on the opposite side, another means would be provided by which some portion of the heat radiated away would be caught and returned to the earth, and a further small reduction in the original receipt of heat from the sun may be made consistently with the existence of life. This outer belt would be very tenuous and its effects correspondingly meagre, but it is a factor to be considered in a complete set of assumptions.

3. If, in addition to this, we make the consistent assumption that many other bodies of the heavens which are now concentrated into suns or into dark bodies were then in a more dispersed nebulous or meteoroidal condition, the general space of the stellar universe would be partially mantled, and there would be less free scope for the escape of the heat, solar and terrestrial alike, which is now freely lost through the open regions of space. It may be conceived that there was a common blanketing of the heavens by the dispersal of its now concentrated matter. This conception is the logical companion of the supposed dispersal of the solar matter. If the volume of matter in the stellar universe could be supposed to be sufficient, it might be so distributed hypothetically as to mantle the whole heavens and largely prevent the escape of central heat outwards, just as the

central heat of the more concentrated bodies is conserved at the present time. Under this conception the history of the stellar universe may be characterized as a progressive clearing-up of nebulosities and meteoroidal dispersions and the concentration of its matter about certain points, leaving between vast open spaces through which heat is now radiated away with a facility unrealized in the earlier stages. The quantitative value of such a suggestion must be left to the determination of astronomers who have the best data for forming a conjecture as to the ratio of matter to space in the stellar universe and as to the possibilities of its dispersion at a period coincident with the earlier stages of the earth's history.

4. A modification of the conditions assumed in the foregoing paragraphs may be postulated in which the earth is regarded as having made its early growth *within* the primordial meteoric aggregate, perhaps a great flattened meteoric spheroid, which initially extended beyond Neptune in nebular fashion and whose present attenuated representative may, perhaps, be found in the zodiacal light. In this case the thermal environment of the early earth was that furnished by the interior of the spheroid, though far out from the center. The conditions only became external gradually as the growth of the planets exhausted the peripheral portion of the meteoric spheroid.

5. The foregoing hypotheses, which do not seem to be so completely out of accord with the possibilities of the case as to be inadmissible tentatively in the absence of a positive solution of the early terrestrial environment, are concerned with the external relations of the earth. If we turn to the earth itself it may be remarked that the nature of its atmosphere very radically conditions the amount of heat requisite for the support of life. Dr. Arrhenius has recently made an elaborate computation relative to the thermal influence of certain factors of the atmosphere and has arrived at the conclusion that an increase of the atmospheric carbon dioxide to the amount of three or four times the present content would induce such a mild climate in the polar regions that magnolias might again flourish there as they did in Tertiary times. On the other hand, he concluded that a reduction of less than 50% would induce conditions analogous to those of the glacial period of Pleistocene times. The vast quantities of carbon dioxide represented in the carbonates and carbonaceous deposits of the earth's crust imply great possibilities of change in the constitution of the atmosphere of the earth in respect to this most critical element.

6. But there are more radical considerations that relate to the early thermal history of the earth. To be sure, if we are forced to adopt the hypothesis of a white-hot liquid earth, with all its extravagant expenditures of energy in the early youth of the earth, we can take no advantage of these possible resources, but under the supposition that the meteorites gathered in with measurable deliberation, it is theoretically possible to find conditions for a long maintenance of life on the earth, with little or no regard to the amount of heat which the early sun sent to it. In the earliest stages of the aggregation of the earth under this hypothesis, while it was yet small, it can scarcely be supposed to have been habitable, because its mass was not sufficient to control the requisite atmospheric gases, but when it had grown to the size of Mars, that is to a size representing about $\frac{1}{10}$ of its present aggregation, or, to be safe, when it had grown to twice the size of Mars, or about one-fifth of its present mass, it would have been able to control the atmospheric gases and water, and, so far as these essential items are concerned, it would have presented conditions fitted for the presence of life. At this stage the

larger portion, four-fifths by assumption, of the matter of the earth would yet be in the meteoroidal form and doubtless more or less closely associated with the growing nucleus. If the infalling of this four-fifths of the material of the earth were duly timed, so as to be neither too fast nor too slow, it would give by its impact upon the atmosphere of the earth a sufficiency both of heat and of light to maintain life upon the surface of the earth. The plunging-down of these meteorites upon the surface might be more or less destructive to the life, but only proportionately more so than the fall of meteorites to-day. It would not be necessarily fatal to life, especially oceanic life; indeed, the strokes of the meteorites might not be more inimical to the perpetuity of any given form of life then than are the attacks of its numerous enemies to-day. It was only another form of jeopardy. The latitude as to variation of rate of infall would be rather large. The infall must not have been so rapid as to have given a universal surface heat above 100° C. The life of hot springs crowds close upon this upper limit, as Lord Kelvin has indicated. The infall must not have been so slow as to have permitted the surface heat to fall universally below 0° C., making allowance for other sources. These other sources might have permitted the meteoric supply to fall considerably below the quantity represented by a surface temperature of 0° C. Between this indeterminable low point and a supply equivalent to 100° C., similarly qualified, there is a quite wide range. Those who have insisted upon the precipitate infalling of meteorites at such a rate as to reduce the earth to a nebulous condition will probably not feel entitled to doubt the adequacy of this source of light and heat. They can only question the possibility of the meteorites falling in slowly enough to permit the coincident presence of life on the earth.

This hypothesis starts life at a period when the earth was one-fifth grown and prolongs it throughout the rather slow gathering-in of the last four-fifths of the earth's mass, and hence gives to the earth a long era of autogenic life conditions.

Now, if a hypothesis relative to the early constitution and the growth of the rest of the solar system concordant with this be entertained, that is, a constitution of a predominantly meteoroidal rather than a gaseous condition, and of a slow rather than a precipitate aggregation, it will, perhaps, appear that the output of heat by the sun in the stages concurrent with this autogenic life period of the earth may have been small. The autogenic thermal era of the earth may thus have corresponded to a period of slight thermal loss by the sun.

As time went on the ingathering of the terrestrial meteorites gradually became more and more distant from one another (since the scattered material was progressively exhausted by previous infalls), while the central or solar aggregation was yet only in its early stages and was gradually increasing in heat. If this increase was in a ratio somewhat proportionate to the decline of the autogenic heat of the earth an equalizing compensation might result, and the earth gradually pass from the relatively independent autogenic thermal stage to the dependent solar stage which has continued to the present. Thus, by the prolonged coincidence of increase on the one side with decrease on the other, the life history of the earth may have been transferred from meteoroidal to solar dependence without such a radical disruption of continuity as to have been generally destructive.

This speculation may seem at first thought to be far-fetched, and to be poised on a ticklish combination of conditions, and it may, indeed, prove, when critically studied, to be really so, but yet it is submitted that it follows along coherent lines connected

ultimately with the fundamental proposition that dispersed meteoroidal matter might gather in slowly rather than precipitately. On this point hangs all the law and the prophets.

If astronomers, physicists and mathematicians will jointly attack the formational history of the solar system stage by stage, following each stage out into details of time and rate, and taking full cognizance of all the alternatives that arise at each stage, it will then be possible, perhaps, to decide whether the conditions of the early earth were such as to require a large or a small amount of heat from the sun for the sustenance of life, and whether the sun was wasting heat prodigally in those days or conserving it for later expenditure. The present measure of the earth's needs may be no measure of its early needs. The sun's present expenditure may be no measure of its early expenditure.

In view of all these considerations, I again beg to inquire whether there is at present a solid basis for any 'sure assumption' with reference to the earth's early thermal conditions, either internal or external, of such a determinate nature as to place any strict limitations upon the duration of life.

The latter part of the address is concerned with novel suggestions regarding the behavior of the supposed liquid surface of the earth in the stages just preceding its final solidification, involving a theory of the formation of the primitive surface rocks and of the original continents and ocean basins. The discussion of this I must leave to the petrologists, merely venturing the hint that they may find some occasion to reconstruct current petrological doctrines if they are to be brought into consonance with the new views offered.

The point of greatest general interest in this part of the address is the sharp statement of opinion that, if the original lava ocean had solidified equably in all its parts and produced a dead-level surface all around the globe, there seems no possibility that our present continents could have arisen to their present heights, or the ocean basins have sunk to their present depths, during twenty or twenty-five million years, or during any time however long. (Exact words previously quoted, p. 897.) Lord Kelvin adds: "Rejecting the extremely improbable hypothesis that the continents were built up of meteoric matter tossed from without, upon the already solidified earth, we have no other possible alternative than that they are due to heterogeneousness in different parts of the liquid which constituted the earth before its solidification" (this JOURNAL, p. 706). This is as strong an assertion of the necessity of assuming crustal and sub-crustal heterogeneity as any advocate of a slow-accretion earth could wish. If the word 'liquid' and what follows be stricken out, and the words 'meteoroidal aggregate' be substituted in the sentence quoted, it will be a rather too strong statement of the alternative explanation which springs obviously from the meteorological hypothesis herein urged. It is not easy to see how such heterogeneity as is required to account for the continents and ocean basins could arise from a white-hot liquid-surfaced earth descended from a gaseous earth. To those who do not follow the petrological conceptions of the address, but who conceive the hypothetical lava ocean to have been one great *solution*, stirred by convectional and other currents and depositing crystals as supersaturation arose from change of temperature or from change in the solution itself, there seems not much more reason to suppose that its deposits would have been localized persistently on the sites of the present continents than to suppose that the present enveloping solution—the ocean—if duly concentrated, would localize in a

similar way the crystals which it would throw down. But this must be left to the petrologists. I cannot, however, express too strongly my appreciation of the value of Lord Kelvin's stalwart opinion respecting the incompetency of the thermal theory of crustal deformation, since this carries with itself, more remotely and occultly (*pace* Kelvin) an implication of like weakness in the theory of the white-hot earth itself.

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*A DANGEROUS EUROPEAN SCALE INSECT NOT HITHERTO REPORTED, BUT ALREADY WELL ESTABLISHED IN THIS COUNTRY.**

In view of the activity and zealousness displayed by several of the European states in excluding American plants and fruits on the pretext of possible contamination with the San José scale, it is opportune perhaps to call attention to the fact that a dangerous and perhaps very dangerous European scale insect, *Aspidiotus ostreæformis* Curtis, has recently become well established in this country. This scale insect is very similar to the San José scale in general appearance and habit, and is liable to be almost, if not equally, as mischievous, judging from the examples of badly infested material which have come to this office for determination.

Aspidiotus ostreæformis is a well-known pest on various fruit trees in Europe, where it has a very wide distribution, but, strangely enough, in view of the ease of its importation on nursery stock, seems not to have gained lodgment in this country until comparatively recently. The first examples of *ostreæformis* coming to this office from American sources were naturally confused with other species, being identified either as *ancylus*, *juglans-regiæ* or *forbesi*, all near allies; and while *ostreæformis* has undoubtedly been established in New York and Ohio for eight or ten years, and in other localities for shorter periods perhaps, its existence in this country has not hitherto been reported in print, and specific identification has only been established within the last year. In fact, so little is the species known that two experts in Coccidæ were prepared recently to describe as new an example, referred to below, coming to Dr. James Fletcher from Pocum, British Columbia. The fact that this material represented the European *ostreæformis*, now first shown to occur in this country, was fortunately determined by Mr. Theo. Pergande in time, I believe, to prevent the publication of the new species.

Within the last few months material representing *ostreæformis* has come to this office and been determined by the writer very frequently, especially from the State of New York, where it seems to have become well established, notably in the vicinity of Geneva. No less that 15 lots of this scale insect have been determined from Geneva, N. Y., representing as food plants plum, cherry and apple. Most of this material has been communicated by Mr. G. G. Atwood, either direct or through Mr. Felt. In one case the food plant is designated as 'European plum,' and the statement is made by Mr. Atwood that the scale occurs in numbers on this food plant, to its considerable injury. Additional localities in New York are: Rochester, on apple (H. C. Peck and V. H. Lowe); same locality, on plum (Dr. Peter Collier), and Millbrook, on pear (E. C. Butterfield, reported as badly infesting 7 pear and 12 plum trees imported eight years before from a German firm); Penfield, on apple (Felt); and also

* The scale insect on pear and apple at Alameda, Cal., collected by Mr. Koebele and determined by Professor Cockerell as *ostreæformis* (Bul. 6, Tech. Ser., Div. Ent., U. S. Dept. Agric., p. 19.), is a case of wrong identification; the species is *juglans-regiæ*, as I have determined from examination of the original material.

from New York State without locality (Felt).

Two localities in Ohio have furnished this scale insect, namely, Wooster, on plum, (F. M. Webster), and Cleveland, on pear (J. A. Stevens). One locality is represented in Michigan, namely, South Haven, on apple, communicated by W. B. Barrows.

In Canada the scale occurs on prune at Pocum, British Columbia (J. Fletcher), and on plum at Niagara, Ont. (Joseph Healey).

A careful examination has been made of all material received at this department representing allied species or those with which there was any possibility of confusion with *ostreæformis*, with the result of the discovery of some half a dozen examples of the latter species. The material earliest received referable to *ostreæformis* bears date of January 12, 1895, and was communicated by Dr. Peter Collier, of the Agricultural Experiment Station at Geneva, N. Y. It was reported as occurring on plum near Rochester, and was identified at that time as *ancylus*, perhaps its nearest American ally. In the same year, April 3, 1895, specimens on plum were received for identification from Mr. F. M. Webster, Wooster, O., and were also referred to *ancylus*. No additional material of this species was received until 1897; in that year Professor W. B. Barrows sent it from South Haven, Mich., and the insect was doubtfully identified as *ancylus*. During 1898 it was received from several localities, as follows: Cleveland, O., on pear; Millbrook, N. Y., on pear; Geneva, N. Y., on plum; British Columbia, on prune, and Niagara, Ont., on plum. In 1899 it was received many times, principally from Geneva. N. Y., and also from Rochester and Penfield, as noted. Its origin on European stock is plainly indicated; possibly the original importation occurring about 1890, although perhaps earlier.

The writer has made mounts and careful studies of this insect from various European localities, and has determined that Signoret's species, *Aspidiotus spurcatus*, is a synonym of *ostreæformis*, and that *A. zonatus* Frauenf., is also probably a synonym, or, perhaps, a mere variety of the same species.

The European localities from which the writer has examined specimens of this scale insect are as follows:

Geisenheim, Germany, on apple, communicated by Dr. L. Reh, Station fur Pflanzenschutz, Hamburg; Isle of Langenau, Nackenheim, Rheinhessen, Germany, on pear sent by Dr. J. Ritzema Bos; Stettin, Prussia, on apple, collected by Mr. Theo. Pergande in July, 1898, 'rather scarce'; Wanganingen, Holland, on pear, sent as probably *perniciosus* by Dr. J. Ritzema Bos; Prague, Bohemia, on *Prunus domestica*, from Mr. K. Sulc; Chester, England, on plum, communicated by Mr. Robert Newstead and labelled as determined by Mr. J. W. Douglas; Florence, Italy, on *Populus tremuloides*, determined as *Aspidiotus spurcatus* (Cherm. It., Fasc. I., No. 3); Italy on *Platanus orientalis*, determined as *Aspidiotus spurcatus* (Cherm. It., Fasc. I., No. 5). On May 19th also, of this year, this scale was found associated with a *Mytilaspis* sp., on cuttings of date palm collected for the Department in Algeria by Mr. Walter T. Swingle.

The species was originally described by Mr. Curtis from pear in England. Mr. J. W. Douglas reports it also in England on plum, pear, apple and cherry, and Mr. A. C. F. Morgan gives the additional food plant, *Caluna vulgaris*, in Portugal, finding it associated with *Mytilaspis pomorum*. On the continent of Europe it has been variously reported as affecting the fruit trees mentioned above.

Aspidiotus zonatus was originally described from specimens found on oak in Vienna. The females occur for the most part on the bark; the males on the leaves. It is widely distributed in Europe. The Department

collection contains specimens from Chester, England (Newstead); and on the white oak from Stettin, Prussia (Pergande).

Aspidiotus spurcatus has been reported from France and Italy on poplar and Platanus.

It will be noted that the Department and other records exhibit not only a wide range of food plants, but a very extended distribution in Europe, both geographically and as to climate. This scale insect, therefore, seems to be one well worthy of attention and one that will bear watching. It is to be hoped that it will not be as disastrous to our fruit interests as have been other foreign scale insects imported to our shores.

C. L. Marlatt.
U. S. Department of Agriculture.

Note: After returning the proof of the above to Science, part of the type material of a supposed new species of *Aspidiotus* (*A. hunteri*), found in 1897 on currant at Alton, Iowa, was sent to this department by the describer of the species, Mr. Wilmon Newell, Assistant Station Entomologist, Iowa Experiment Station. The material in question proves to belong to *ostreæformis*, and is very interesting as showing the occurrence of this species so far west and also as indicating a new food plant.

CROSS-EDUCATION.

The term 'cross-education' is used to express the theory that the effects of practice on one side of the body are transferred to the unpracticed side. The subject has been investigated during the past year at the Yale Psychological Laboratory in the effort definitely to establish the fact of transference of practice and to arrive at an explanation of the causes of such transference. Following is a brief summary of the experiments carried on and the results obtained from them:

a. Rapidity of voluntary effort.—A tap-counter was constructed from clock-work and connected electrically with a telegraph key. At each pressure of the key by the hand or the foot the counter registered one tap. Records of maximum rapidity of tapping were taken for right and left index fingers and right and left great toes separately. Then for two weeks the right great toe alone was practiced in tapping daily for a considerable time. Then all four digits were tested as at the start. The result for six subjects showed that the average relative gain for the right great toe—the member practiced—was 31% ; for the left great toe, 30% ; for the right index finger, 20% ; for the left index finger, 28%. The last three had, therefore, gained by practice of the first.

b. Strength of voluntary effort.—Six subjects were tested as to the number of times they could raise a dumb-bell weighing $2\frac{1}{4}$ kilos (5 lbs.). Girth measurements of the right and left arms were taken and the dynamometric pressure of each hand was determined. For two weeks the right arm alone was exercised in raising the dumb-bell. Results: (1) The average gain of the right arm in the number of flexions made was 470%; of the left arm, 150%. (2) The average gain in the girth of the right biceps was $6\frac{1}{3}$ mm.; of the left biceps, $2\frac{5}{6}$ mm.; of the right forearm, $4\frac{5}{6}$ mm., and of the left forearm, $2\frac{1}{6}$ mm. (3) The average dynamometric pressure increased in the right hand 13%, in the left 13%. (4) Practice of the *right* arm inured *both* arms to resist the after-effects of violent exercise as revealed by stiffness, pain and soreness. These experiments proved not only the fact of cross-education in ability to do work, but also the fact of cross-development, in a lesser degree, of the symmetrical muscles.

c. Accuracy of voluntary effort.—A target was so devised that permanent records of accuracy in lunging with a fencer's foil could be obtained. Records of both right and left hands were secured with six subjects. The lunging was then practiced for two weeks with the right hand only. Thereafter both hands were tested. Results: (1) Both hands had gained in accuracy,

the right 52%, the left 36%. (2) In both right- and left-handed lunging, the body had gained in grace and coordination of movement. (3) The probable errors of both hands had been markedly decreased as the result of the practice of the right hand.

Cross-education may be the result chiefly of changes wrought in the central nervous system. In the tapping, in which a minimum of muscular strength is required, the gain is about equal on both sides. In the test of strength a smaller proportional gain was found in the side not practiced. The transference of peripheral effects cannot be ignored altogether, since in the dumb-bell test there was a decided increase in the girth of the arm not practiced, and in its power to resist fatigue.

The facts may be explained as the result of two factors: (1) the close nervous connection, through motor centers, between symmetrical muscle groups on opposite sides of the body and between groups related in function or position; (2) the development of general will power and attention, through the practice of one form of volition.

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SCIENTIFIC BOOKS.

The History of Mankind. By FRIEDRICH RATZEL. Translated from the second German edition by A. J. BUTLER, M.A. With introduction by E. B. TYLOR, D.C.L., F.R.S. London, Macmillan & Co. 1898. Colored plates, maps and illustrations. Volume III. 8vo. Pp. 599.

The first edition of Ratzel's 'Völkerkunde,' which has been in our libraries for ten years, is divided into three substantial parts or volumes, the third of which is taken up with the more cultured peoples that are outside of the age of steel and steam. For some reason or other, the order of the work has been changed in the English edition. The higher American peoples are thrust out; Africa obtrudes itself into Volume III., so that it really commences on page 149. It is with the remaining pages that we have here to deal.

The proper appreciation of this volume and, indeed, of the whole work, demands of the reader familiarity with his Peschel, Friedrich Müller, Brinton and Keane, and he would do well to have near by a set of Standford's Compendiums. It is not a treatise on ethnology—the work would be vastly improved by a few tables showing the connection and affiliation of peoples—but a discussion of human artificialities in relation to certain culture areas.

The eastern hemisphere presents to the student a number of arenas on which the drama of mankind has been enacted. On these, races come and go, but Nature's life repeats itself and the forces of progress and reaction are imperceptibly active in them.

In speaking of this play of culture-influences between Africa and Asia the author develops the Erythræan, or Red Sea group of peoples. In contrast with Dr. Brinton's emphasis upon the Hamite and West African forces, Ratzel looks eastward for the predominating influences.

The arena for the sharp conflict between nomad pastorals and settled tillers is found in a broad strip of territory extending diagonally from 10° to 60° north latitude and from the Atlantic to the Pacific.

India is for the author a region where races have been broken up, pulverized and kneaded by conquerors. Doubtless a pre-Dravidian negroid type came first, of low stature and mean physique, though these same are, in India, also the result of poor social and economic conditions. Dravidians succeeded negroids, and there may have been Malay intrusions, but Australian affinities are denied. Then succeeded Aryan and Mongol, forming the present *pot pourri* through conquest and blending.

Northward of India, as suggested, the settled Iranian and the nomad Mongol furnish to the author the best opportunity to study and develop the thought ever dominant in his mind. In the history of mankind the lots fall diversely, but to each race its task is assigned, and none is left without opportunity of casting its threads into the great fabric.

In southeastern Asia, Ratzel sees a great

Transgangetic family of language, with older and more recent members, the former squeezed into the sea board and the mountains, the latter spreading over the interior and along the streams to the deltas.

The Far East gives to the author his best perspective—in the remotest past, a rude stone age no better than that across the Pacific, in California; after that, three thousand years B. C., a bronze age; and then the gradual but victorious progress of the race, its customs and institutions. Japan and Korea are daughter races of Chinese culture. The closing section of this Asiatic portion of the volume is devoted to Asiatic forms of belief and systems of religion. The necessity of religion is assumed, and, as to its forms in the arenas mentioned, "they have their roots in a subsoil of widely diffused notions, in which even now leaves, flowers and seeds, fallen from the lofty trees, are reposing, dying, decaying, germinating."

Ratzel is not in ecstasies over the blessings of the age of iron and machinery. We are liable, he thinks, to overestimate the effect of metals in promoting culture. "The discovery of smelting and forging does not form an epoch. The spiritual foundations of our culture had no workers in steel."

So, the Europeans receive only a passing notice on the last few pages and are handed over to the historian.

In a work upon which the author has expended so much care and erudition one could wish that he had made more concessions to the reader. Few persons are learned enough to read the volume before us. If they desire to consult the authorities named, it is nearly unpractical, and the translation is not so helpful as the original. The illustrations are superb; they embellish and illuminate the work, but they do not greatly illustrate it. For example, the Kha flute, on page 370, after Harmand, finds no explanation for its strange combination of direct flute and reed instrument, and no example is in the national collection. As a summary of culture, however, among the peoples of the eastern hemisphere, still in the epoch of handicraft, Ratzel's third volume is not only vastly superior to such books as Wood's, which is saying little, but it places the author in the front rank among the students of culture-progress, whose pioneers were Klemm, Lubbock, Tylor and Morgan.

O. T. Mason.

Smithsonian Institution.

Canada Experimental Farms Reports 1891–1898, Vols. 8, pp. 348, 289, 355, 422, 426, 474, 449 and 429. Illustrated.

The system of Experimental Farms of the Dominion of Canada was inaugurated in 1887, with the establishment of the Central Experimental Farm at Ottawa. Since then, as parts of the system, branch farms have been located at Nappan, Nova Scotia, for the Maritime Provinces; Brandon, Manitoba; Indian Head, Northwest Territories, and Agassiz, British Columbia. Each of the branch farms is under the direction of a Superintendent, who reports to the Director at the Central Farm, and he in turn to the Minister of Agriculture, the annual report being issued as an appendix to the report of the Minister of Agriculture. The organization of the Central Farm is somewhat like that of the Experiment Stations in this country, and the staff during most of the period covered by the above reports consisted of William Saunders, Director; James W. Robertson, agriculturist; John Craig, horticulturist; F. T. Schutt, chemist; James Fletcher, entomologist and botanist, and A. G. Gilbert, poultry manager. A foreman of forestry, W. T. Macoun, since made horticulturist, was added to the force during the period covered by the report for 1897.

At the several farms many lines of useful work are carried on, such as scientific investigations, practical field work, the study of forestry problems, etc., different problems being investigated according to the immediate needs of the farming community, but at the Central Farm the greater part of the more important scientific investigations are carried on, this institution being especially equipped for the purpose. In addition to the duties already outlined, the Central Farm has charge of the introduction and distribution of seeds and plants, a few thousands of dollars being annually expended in purchasing and distributing seed grain and forest trees and tree seeds.

The reports of the Experimental Farms give

the results of experiments in agriculture, horticulture and arboriculture, the outcome of practical work in the fields, barns, dairy and poultry buildings, orchards and plantations, as well as scientific investigations in the chemical laboratory and the results of studies of the life history of injurious insects and noxious weeds. Variety tests have occupied much of the attention of the agriculturist and horticulturist, the evident desire being to secure the best varieties for the different regions. In this way experiments in the adaptation of certain crops and varieties are conducted upon a scale impossible to the individual, and not a few valuable crops have been secured by this means. Methods of culture and the proper use of fertilizers have been quite thoroughly investigated, to the advantage of the several constituencies. In the treeless regions of Manitoba and Northwest Territories tree-planting experiments have been conducted since the establishment of the branch farms in these Provinces, and, as a result, it is now possible to suggest lists of trees and shrubs adapted for hedge, shelter and timber growth in those regions.

Among results of particular interest and of far-reaching importance noted in the last report is the account of experiments on the effect the plowing under of clovers has on subsequent crops. These experiments have been continued for four years and the beneficial effect of such procedure is plainly shown.

In connection with the variety tests of the agriculturist, attention should be called to the very excellent work done in cross-breeding of cereals. At least two score cross-bred varieties of wheat, and quite a number of varieties of oats, barley and peas have had their origin on the Experimental Farms and some of them seem to be peculiarly adapted to the region, being of more than average productivity and quite resistant to fungus attacks.

The dairy investigations and the experiments in feeding farm animals, especially steers and pigs, have been noteworthy and have led to some very practical results. In nearly every case the feeding experiments were repeated year after year and the conclusions verified.

Among the investigations made by the chemist, the comprehensive survey made of the typical soils of the different Provinces in which their physical characteristics and chemical constituents were determined stands out prominently.

The study of the life history of injurious insects and the investigation of means for combating their attacks have occupied much of the time of the entomologist and botanist. In addition, the subject of noxious weeds, their dissemination and eradication has been investigated. With such subjects as these the efficiency of any method for the destruction of these pests depends largely upon timely warnings which have been given as the emergency arose. Spraying for the prevention of plant diseases has come in for attention and the suggestions given are timely and practical.

The poultry manager has been concerned principally with studying the relative values of different breeds of fowls and their feeding and management.

Throughout all the reports the intensely practical nature of the work is everywhere manifest, the desire apparently being to give results of investigations that may be of immediate use to the farmers and others of the Dominion.

WALTER H. EVANS.

OFFICE OF EXPERIMENT STATIONS,
WASHINGTON, D. C.

BOOKS RECEIVED.

Naturalism and Agnosticism. JAMES WARD. New York and London, The Macmillan Company. 1899. Vol. I., pp. xviii+302; Vol. II., pp. xiii+294. $4.00.

La géologie expérimentale. STANISLAS MEUNIER. Paris, Alcan. 1899. Pp. viii+306 and 56 figures. 6 fr.

Manual of Bacteriology. ROBERT MUIER and JAMES RITCHIE. Edinburgh and London, Young J. Pentland; New York, The Macmillan Company. 1899. Pp. xviii+564.

SCIENTIFIC JOURNALS AND ARTICLES.

THE leading article, in every sense, of the *American Naturalist* for June is that of Sylvester D. Judd on 'The Efficiency of Some Protective Adaptations in securing Insects from Birds.' The author's conclusions, based upon four years' study of the food habits of birds, are that the alleged protective coloration is not the all-important factor in securing an insect from ex-

termination, as some earlier naturalists have supposed. G. C. Whipple and Horatio N. Parker present 'A Note on the Vertical Distribution of Mallomonas.' While the reasons for the peculiar distribution are not wholly apparent, it apparently depends on light and temperature, the organism preferring to live where the light is strong, the temperature low and the water quiet. In an article on 'The Colors of Northern Monocotyledonous Flowers' John H. Lovell considers that the primitive color of the perianth was green, that physiological conditions have often played an important part in determining the coloration of the petals, while insects have contributed to the fixation of such characters when once acquired. William L. Tower records the curious 'Loss of the Ectoderm of *Hydra Viridis* in the Light of a Projection Microscope,' this loss occurring almost completely in from one to eleven minutes. The diagrams illustrating this paper have been transposed. The editor makes the welcome announcement of the forthcoming publication in the *Naturalist* of a series of synoptical tables for the determination of American invertebrates.

Bird Lore for June commences with an all-too-brief note by Frank M. Chapman on 'Gannets on Bonaventure,' accompanied by a full-page plate showing the nesting gannets on one of the ledges. Florence A. Merriam concludes her article on 'Clark's Crows and Oregon Jays on Mount Hood,' and Mary F. Day gives some excellent observations on the Chimney Swift under the caption 'Home-Life in a Chimney.' William L. Baily shows 'Three Cobb's Island Pictures,' with notes thereon. Ella Gilbert Ives writes of 'The Cardinal at the Hub,' and Thos. S. Roberts has an illustrated 'Catbird Study.' Olive Thorne Miller discusses 'The Ethics of Caging Birds,' deciding that this may be done, if properly done. Fred. H. Kennard tells of the birds of 'A May Morning,' and Mildred A. Johnson of those seen on 'A February Walk.' If one might venture a criticism on *Bird Lore* it would be to the effect that the 'young observers' seem to be getting more than their fair share of space.

Terrestrial Magnetism and Atmospheric Electricity for June. As already announced in SCIENCE, this journal is now being issued from the Johns Hopkins University press, Dr. Bauer remaining as editor-in-chief. In view of the addition of atmospheric electricity to the scope of the journal an appropriation has been made to it from the Hodgkins fund of the Smithsonian Institution. The contents of the number before us are as follows: Portrait of Charles A. Schott, Frontispiece; 'The Beginnings of Magnetic Observations,' G. Hellmann; 'Carte Magnétique de la Sicile,' L. Palazzo; 'The Magnetic Work of the United States Coast and Geodetic Survey,' L. A. Bauer; Über einige Probleme des Erdmagnetismus und die Nothwendigkeit einer Internationalen Organisation,' M. Eschenhagen; 'The Secondary Magnetic Field of the Earth,' A. W. Rücker; 'Remarks upon Professor Rücker's Paper and Wilde's Magnetarium,' L. A. Bauer; 'Biographical Sketch and Portrait of Dr. John Locke,' L. A. Bauer; 'Mean Values of Magnetic Elements at Observatories,' C. Chree; Notes, 'Biographical Sketch of Charles A. Schott.' Activity in magnetic work.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the meeting of this Society, held on May 10, 1899, three papers were read, of which abstracts follow:

Mr. S. F. Emmons read a paper entitled '*Plutonic Plugs and Subtuberant Mountains*,' new terms introduced by Professor I. C. Russell in two articles in Volume IV. of the *Journal of Geology* (1896), to designate hitherto unobserved geological phenomena, the one being a new form of igneous intrusion distinct from laccoliths, the other a new type of mountains. The latter, to which his second article is devoted, are dome-shaped mountain uplifts with granitic cores, which he considers to have resulted from the vertical upthrust exercised by the intrusion of a larger plutonic plug (or *tuber*) beneath their center, and are called by him 'subtuberant mountains.' The idea of vertical upthrust had already been advanced by Dutton in his article on Mt. Taylor, N. M., in which he stated that all the mountain uplifts between the Great Plains and the Sierra

Nevada had been produced by rising granite cores, which might or might not have reached the surface or been exposed by erosion. So far as facts in support of this theory were instanced by Professor Russell for regions that had come under the speaker's observation, Mr. Emmons said they were not correctly stated or interpreted, and that Russell had apparently taken his ideas with regard to the Colorado mountains rather from the early reconnaissance observations of Hayden than from what had been written since in the light of modern geological research. It was only during the past summer, however, that an opportunity had presented to verify the personal observations in the northern Black Hills, upon which Russell based his original discovery. A detailed survey of this region is in progress by members of the U. S. Geological Survey, under Mr. Emmons's general supervision, the results of which, though not ready for publication, show that Russell's own observations, which were confined to three outlying groups of hills, were inaccurate. His supposed plugs are either laccoliths or remnants of laccolithic sheets left by erosion. In describing the other occurrences to support his plug theory Russell had relied mainly on the reconnaissance observations of Winchell and Newton made 25 or 30 years ago, before laccoliths were known, and paid little attention to later observations. In point of fact, the region presents a most remarkable variety of typical laccoliths, and nothing corresponding to the supposed plutonic plug has yet been observed there. Russell's further statement in support of the plug theory, 'that dikes and faults are wanting in the region,' is equally without basis of fact. Crosby, in the article casually referred to by Russell, speaks of the abundance of dikes in certain localities, and observation has shown that both dikes and faults are so abundant in the central mining region that they could hardly escape notice.

The speaker thought such hasty generalizations were objectionable as establishing an undeserved priority in terms that when accurately defined and applied to observed phenomena might be useful to field geologists.

This paper was followed by one upon *Laccoliths and Bysmaliths*, by Walter Harvey Weed, the subject being a sequel to that previously discussed. The facts upon which the paper was based related mainly to the igneous intrusive mass of the Little Belt Mountains, of Montana, in which careful areal surveys have been made, but supported by observations made for ten years past in neighboring parts of the State. These intrusions commonly occur in Cambrian shales, and rest upon crystalline schists. They present gradations from intrusive sheets to laccoliths, and from these to asymmetric laccoliths. Incidentally, it was shown that the asymmetry is due to the general range uplift, furnishing a line of weakness along the limb or monoclinal of the fold. Several of the intrusions are, however, unlike the laccolith, unless we assume an asymmetry about the entire circumference. In other words, faulting and uplift, and not folding, is the prevailing structure. As the field observations show the same spreading out on a definite floor as in the case of the laccolith, these intrusions are not stocks or the so-called plugs of many writers, a term lately revived under the title of Plutonic Plug by Russell. Moreover, gradations occur between them and the asymmetric laccolith.

For such intrusions Professor J. P. Iddings has recently proposed the name of *bysmalith*. It is clearly a form heretofore embraced under the more general term of 'stock.' Its usefulness consists in its affording a definite name for a definite type of intrusion, of which several examples have now been observed.

From a study of the facts observed in the field, it appears that there is a definite relation between these different forms of intrusion, and the form is a function of several factors. The other factors being equal, and lines of weakness absent, a bysmalith has a larger floor area than the laccolith, which accords with the hypothesis that owing to viscosity of the intruding magma the pressure in large masses is imperfectly transmitted laterally, resulting in an increased upthrust producing faulting and the punching upward of the strata. Such intrusions have been described by Davis and Lindgren, though no name was given them. As the term laccolith is preferable to stone cistern, so bysmalith is preferable to plug-stone, both having special meanings not implied by the English transla-

tions of the names, especially as the term plug as used by geologists, including Russell, does not imply lateral expansion.

The third and last paper was by Mr. J. A. Taff. Mr. Taff's observations on '*Changes in the Canadian River in Western Choctaw Nation, Ind. Ter.*,' brought out facts showing that this river once flowed from where it now crosses the Choctaw-Chickasaw line southeastward, well into what is now the hydrographic basin of Red River; that the present river has eroded its bed 100 feet below its old channel; that the old river was 1 to 3 miles wide and had filled its channel with sand, as the present river has done. The migration of the Canadian northward was shown to be, most probably, due to capture by a tributary of Little River by headwater erosion along the strike of friable beds of sandstone and shale. The old channel of Canadian River was surveyed and mapped for 50 miles. WM. F. MORSELL.

MAY 15, 1899.

TEXAS ACADEMY OF SCIENCE.

THE annual June meeting of the Academy was held at Austin on the 12th inst. The following papers were presented :

1. Some Theorems in Geometry : Dr. W. H. Bruce, Athens, Texas.
2. Southwestern Texas : William Kennedy, Austin.
3. The Ecology and Embryology of the 'Rain Lilies :' Felix E. Smith, Austin.
4. 'An Annotated Record of the Geology of Texas for the Decade Ending December 31, 1896,' with remarks : Dr. Frederick W. Simonds.
5. A Case of Fistula on the Neck of an Adult Man : Dr. W. W. Norman.
6. The Behavior of Certain Caterpillars : Dr. W. W. Norman.
7. Life Zones and Crop Zones in Texas : Dr. William L Bray.

The election of officers, which occurs annually in June, resulted in the following choice:

President, Dr. Frederic W. Simonds, University of Texas.

Vice-President, R. S. Hyer, Regent of Southwestern University, Georgetown, Tex.

Treasurer, Professor T. U. Taylor, University of Texas.

Secretary, Dr. William L. Bray, University of Texas.

Librarian, Dr. W. W. Norman, University of Texas.

First Member of Council, H. L. Hilgartner, M.D., Austin, Tex.

Second Member of Council, Professor J. C. Nagle, Agricultural and Mechanical College, College Station, Tex.

Third Member of Council, Dr. H. W. Harper, F.C.S. London, University of Texas.

The office of Librarian was created by vote of the Academy, and the Librarian made *ex-officio* member of the Council. The Academy library, consisting thus far of valuable exchanges, is assuming gratifying proportions.

WILLIAM L. BRAY, *Secretary.*

TORREY BOTANICAL CLUB, MAY 31, 1899.

ON the part of the Committee on Nature Study, Miss Sanial described briefly the use of plant material in the vacation schools of New York City, and the need of donations of fresh flowers and other natural objects. They are used for study and for brush work. Many of the children have never seen any wild flowers whatever. Any one who will write to the Board of Education, labeling the communication 'For Vacation Schools,' will receive the necessary blanks for forwarding, and such contributions of plant material are earnestly desired.

Dr. Arthur Hollick followed with a brief abstract preliminary to a paper entitled 'A Comparison between Geological Sequence and Biological Development in the Vegetable Kingdom." He alluded to the first occurrence of modern genera in the Mesozoic, and of modern species in the Tertiary; and to the vigorous growth made by lower forms of algæ in the hot waters of Yellowstone Park, suggesting that similar algal life was probably characteristic of the earlier heated waters of the globe. He stated that many of the Cambrian casts claimed to represent algæ are undoubtedly rightly interpreted; and then sketched the successive appearances of the earliest known gymnosperms, in the Devonian, monocotyledons, in the Triassic, and dicotlyedons in the Cretaceous, by the middle of which period many modern genera are recognized. Ferns and Lycopods of modern families appeared in

the Devonian, the first known Musci, Hepatica and Fungi in the Tertiary. Plant remains in glacial deposits are exactly the same as species now living a little farther to the north. The Carboniferous fern-species which have been figured and named outnumber those of the whole world now living. The coal flora was probably practically identical all over the world. Every time a new horizon is opened up, even down to the Tertiary, there are many new fossil ferns discovered in it. A species in paleobotany simply means a description of a certain organism. We may find that some or many of these actually belong to the same species.

Discussion followed, in which Dr. Underwood, Mr. Eugene Smith and the Secretary participated. Dr. Underwood called attention to the descent of the ferns, not from the mosses, but probably from earlier generalized ancestors of both; and spoke of the disparity in numbers between the fossil and the living ferns of Pennsylvania—45 living, but at least 375 fossil—and and asked: "How many of the 45 now living in Pennsylvania are at present being preserved in sediments?" Many of them are seldom found above ground, to say nothing of their occurrence beneath.

The second subject presented was the exhibition and description of a hygroscopic plant-specimen by Dr. C. J. Eames. The specimen was originally described in an article entitled 'The Resurrection Flower' in *Harper's Monthly*, April, 1857, p. 619. Dr. Eames' specimen seemed as if it were the ripened circle of ovaries of some malvaceous flower, and displayed very marked hygroscopic movement, expanding completely within fifteen minutes after moistening. Dr. Eames, a chemist, obtained his specimen in 1860 from Dr. I. Deck, a chemist, who said that he had secured this, and one other like it, about 1849 when in Upper Egypt. The other specimen passed into the possession of Humboldt. Dr. Eames exhibited specimens of *Selaginella* and *Anastatica* for comparison, their hygroscopic movement being less perfect. In the discussion following Dr. Schoeney stated that he has retained *Equisetum* spores which have held their hygroscopic power for ten years unimpaired.

EDWARD S. BURGESS,
Secretary.

BOTANICAL NOTES.

THE POPULARIZATION OF BOTANY.

FROM time to time attempts are made to popularize some department of science, with less or more success according to the abilities of the author. In this country we have had many illustrations of how not to do such a work, with a few examples which have been successful. Botany has perhaps more than any other science suffered from the attempts of unprepared authors, and, as a consequence, we have had a swarm of books and booklets filled with all kinds of misinformation in regard to plants. It is little, if any, better abroad, but there one finds, now and then, a really good book which is popular in style and yet accurate in regard to its matter. Perhaps the explanation of the latter fact may be found in the other fact that occasionally an eminent botanist undertakes the task of writing for the people. One of the latest illustrations of this is the third edition of Van Tieghem's 'Eléments de Botanique.' That the author is thoroughly prepared to present the subject needs no discussion here, and an examination of the text shows that he has been able to present it in such form as to make it readable to any one of ordinary ability. This result has been attained by the use of vernacular terms, or, where these did not exist, by the modification of technical terms into forms which so nearly resemble the vernacular as to be readily accepted by the ordinary reader. In this manner the author is able to discuss, in successive chapters, topics like the following: the body of the plant, the root, the stem, the leaf, the flower (in all of which the morphology is first taken up and then followed by the physiology), development of the phanerogams, formation of the egg and development of vascular cryptogams, formation of the egg and development of mossworts, formation of the egg and development of thallophytes, development of the race. In the second part of his book the author boldly takes his readers through the difficult field of systematic botany, from thallophytes to phanerogams, closing with a chapter on the distribution of plants.

We do not have to agree with what we must regard as little better than scientific vagaries in some portions of the author's discussions of the

relationships of certain flowering plants when we express admiration for the general plan and spirit of the work. We do not have to approve of many of the attempts of the author to avoid the use of Latin names of plants in order to be able to say that the book is one to be commended. The author has shown us how a scientific man may write so that the people may read and will read what is written. For this we owe him our thanks. We do not like 'Albuge blanc' for *Albugo candida*, 'Beggiate blanche' for *Beggiatoa alba*, 'Charagne fragile' for *Chara fragilis*, 'Botryche lunaire' for *Botrychium lunaria*, 'Welwitschie admirable' for *Welwitschia mirabilis*, 'Oponce vulgaire' for *Opuntia vulgaris*, etc. On the other hand, many of the author's modifications of the Latin names are quite happy : for example, 'Puccinie du gramen' for *Puccinia graminis*, 'Tilletie du Blé' for *Tilletia tritici*, 'Pézize' for *Peziza*, 'Oedogone' for *Oedogonium*, Zygnème' for *Zygnema*, 'Pteride' for *Pteris*, 'Agroste' for *Agrostis*,' Myriophylle' for *Myriophyllum*, etc. When an American botanist who is prepared to undertake the work sets about the task of writing a botany for the people he will do well first to pretty carefully read Van Tieghem's book.

REPORT OF THE MISSOURI BOTANICAL GARDEN.

THE Tenth Annual Report of the Missouri Botanical Garden has just come to hand, and we are able again to form some estimate of the value of the gift which Henry Shaw made to Science when he set aside a fortune for the endowment of the Garden. From the report of the financial officers we learn that the net available income derived from the endowment after paying taxes, insurance, repairs, etc., is also a little more than $37,000. Of this sum about $21,000 have been used in the maintenance and improvement of the Garden as a collection of plants. About $13,000 have been used in providing for the expenses connected with the scientific work of the Garden, including the herbarium, library, research work and publications. The remaining $3,000 have been used for the Shaw School of Botany, and for the expenses of the annual 'Flower Sermon,' 'Flower Show,' and banquets, which were designated by Mr. Shaw. A careful study of the financial report shows that the trustees are so managing the estate as to increase its value, apparently with an eye to its greater usefulness in the future.

The net results botanically each year are the maintenance of a botanical garden of high scientific importance, and provision for the library, herbarium and publications which pertain thereto. We have now had ten reports, each including scientific papers of a high order of merit, dealing with many phases of botanical work. A few titles will suffice to show the range of these papers, as follows: 'Revision of the North American Species of *Sagittaria* and *Lophotocarpus*,' 'Juglandaceæ of the United States,' 'A Revision of the American Lemnaceæ occurring North of Mexico,' 'A Revision of the Genus *Capsicum* with especial reference to garden varieties,' 'List of Cryptogams collected in the Bahamas, Jamaica and Grand Cayman,' 'A New Disease of Cultivated Palms,' 'Notes on the Grasses in the Bernhardi Herbarium collected by Thaddeus Haenke and described by J. S. Presl,' 'A Sclerotioid Disease of Beech Roots.' A list has been published of the books and papers which have emanated directly and indirectly from the Garden, which shows that during the brief period of its existence no less than two hundred and twenty-three contributions have appeared. Could the generous founder return to see the results of his philanthropy he would doubtless feel that his hopes had been more than realized.

ATLAS OF OFFICINAL PLANTS.

THE second edition of Berg and Schmidt's 'Atlas der Officinellen Pflanzen,' which has been under way for several years, has reached the twenty-fourth *Lieferung* and Plate 140. The work maintains its high degree of excellence, and the plates are particularly to be commended for their scientific accuracy as well as beauty of drawing and coloration. When completed, this work will be of the greatest value to the student of medicinal plants, while at the same time it will be useful to the general botanist.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

MEASUREMENTS OF ASYLUM CHILDREN.

DR. ALES HRDLICKA has recently published a paper containing a series of very interesting 'Anthropological Investigations on One Thousand White and Colored Children of Both Sexes,' inmates of the New York Juvenile Asylum. The principal aim of these investigations was to learn as much as possible about the physical state of the children who are being admitted and kept in juvenile asylums, while it was also intended to add to our knowledge of the normal child and of several classes of abnormal children. It is well known that a large proportion of the children admitted to juvenile asylums are sent there on account of the poverty of their parents, while another large contingent are committed as incorrigible or even criminal. As both these classes are, from a sociological point of view, abnormal, it is important to learn how far their physical characteristics conform to their moral character, in order to justly decide whether or not they are materially handicapped in their struggle for life, since their treatment and prospects would depend largely on the answers to this question. Dr. Hrdlicka's observations and measurements have a direct bearing on this point, while they are also of value to the anthropologist and zoologist.

While the asylum children are of somewhat smaller stature and smaller weight than were the outside children available for comparison, these deficiencies are probably due to lack of nutrition caused by poverty; measurements of the heads show no great departure from what is considered normal. Criminal and vicious children are not, *as a class*, characterized by any considerable physical inferiority, while the mental ability of at least 85 *per cent.* was equal to the average ability of children outside the institution. Dr. Hrdlicka, therefore, concluded that this class of children make a favorable showing and, with proper treatment, give great hopes as to their future. It is considered of great importance that such children should remain sufficiently long in the asylum to enable them to acquire and retain good habits.

It is found, while the variety of abnormalities existing among the inmates of the asylum is very great, that there is no one abnormality nor set of abnormalities characteristic of the children as a class, and that the characters are usually so slight as not to interfere with any progress the children might otherwise be capable of.

The fact that certain pretty constant differences exist between the colored and white children is of considerable interest, the more that, zoologically speaking, these differences are such as to indicate that the negro is more generalized than the white. Thus the negro children exhibit more uniformity in their physical characters and less tendency to congenital variation, although more succeptible to acquired abnormalities, chiefly the results of rachitic conditions. The ears of many show an almost specific character in having the helix bent on itself and compressed at the highest fourth of the ear; the arms are slightly longer, and in general the bodies of the negro children show less adipose tissue and more muscular development.

All in all, the report deserves to be read with care. F. A. L.

SCIENTIFIC NOTES AND NEWS.

YALE University has conferred the degree of LL.D. on Professor Charles Sedgwick Minot, of Harvard Medical School, and on Dr. Emory McClintock, of New York, lately President of the American Mathematical Society.

HARVARD University has conferred the degree of LL.D. on Professor Arthur T. Hadley, President-elect of Yale University.

HOBART College has conferred the degree of LL.D. on Professor W. K. Brooks, of the Johns Hopkins University.

PROFESSOR NEWCOMB attended the meeting of the Paris Academy of Sciences, of which he is the only American honorary member, on June 12th.

FRANK SCHLESINGER, PH.D. (Columbia), has been appointed an observer in the United States Coast and Geodetic Survey, and will be stationed at Ukiah, Cal., where he will take part in the international plan for the determination of the variation of latitude.

M. HENRI MOISSAN was elected an honorary member of the German Electro-chemical Society at its recent meeting at Göttingen.

DR. P. F. RAYMOND, the successor of Charcot in the chair of nervous diseases at the Saltpêtrière, has been elected a member of the Paris Academy of Medicine.

THE University of Michigan has conferred the degree of S.M. on Dr. Charles F. Brush, of Cleveland, and Professor W. W. Campbell, of Lick Observatory. They are both graduates of the University of Michigan.

PROFESSOR H. A. PILSBRY, of the Philadelphia Academy of Natural Sciences, has received the degree of Doctor of Science from the University of Iowa.

WE learn with regret of the death of W. W. Norman, professor of biology at the University of Texas, from typhoid fever at Boston.

AT the approaching meeting of the French Association for the Advancement of Science at Boulogne a monument of Duchenne, known for his contributions to electro-therapeutics will be unveiled. The Association will for the first time have a Sub-section of Electro-physiology.

THE Maryland Geological Survey has established a laboratory for the physical analysis of soils, and Mr. C. W. Dorsey, of the U. S. Department of Agriculture, has been detailed to superintend the work. A full outfit of apparatus similar to that used by Professor Whitney in the physical determination of soils has been installed, and work will be continued during the coming year upon the soils of Maryland, in conjunction with the geological surveying of the same area. The Survey has further recently had constructed by Mr. Henry J. Williams, of Boston, a very elaborate calorimeter for the determination of the calorific power of coal, preparatory to the investigations of the coal formations of Maryland, which will afford the subject for an exhaustive report at an eaily date.

WE learn from the *American Geologist* that the Minnesota Academy of Natural Sciences will send to the Greater American Exhibition at Omaha a collection illustrating the natural history of the Philippine Islands. The collection will comprise nearly 1,000 birds, a large number of vertebrates, including huge bats and snakes, a collection of shells and corals, and an elaborate ethnographical display.

THE observations at the Magnetic Observatory at Vienna have had to be discontinued on account of the electric tramways and electric light wires. *Terrestrial Magnetism* states that the Director of the Observatory, Professor Pernter, has submitted a plan to the Austrian government for a new Observatory, to be situated some distance from Vienna, and to be provided with instruments of the latest construction.

WE learn from the *National Geographic Magazine* that Col. W. S. Brackett, of Peoria, Ill., has organized and equipped an expedition to determine the geological and mineralogical features of the almost unknown region lying between Buffalo Hump, in Idaho county, Idaho, and the Nez Perce Pass, in the Bitter Root range. The party numbers twelve men, all experienced mountaineers, some of whom have been in that country since 1862.

THE U. S. Fish Commission steamer *Fish Hawk* has arrived at Woods Holl and will be used for biological work throughout the summer.

IN compliance with a request of Governor Roosevelt, the Hon. Andrew H. Green, President of the Society for the Preservation of Scenic Historic Places and Objects, has appointed a committee to confer with the New Jersey commission in regard to the preservation of the Palisades. The committee consists of Edward D. Adams, Abram G. Mills, George F. Kunz, Fred. S. Lamb and Edward Payson Cone, all of New York City.

SURGEON J. C. BOYD, of the Navy, one of the United States delegates to the recent Tuberculosis Congress in Berlin, has returned to Washington, and is preparing a report for the Department on the work of the Congress. Dr. Boyd thinks that the results of the Congress are important.

AT a meeting of the American Fisheries Society, held at Niagara Falls June 28th and 29th, it was voted to hold the next annual meeting at the Station of the U. S. Fish Commission, Woods Holl, Mass.

UNDER the auspices of the Royal Horticultural Society of London an International Conference will be held this month on the hybridization of plants. The U. S. Department of Agriculture will be represented by Mr. H. J. Webber.

INVITATIONS have been sent for the Fourth International Congress of Psychology, which will be held at Paris from the 20th to the 25th of August, 1900. The organization is left to the French members, the following being the officers: President, Th. Ribot, professor of experimental and comparative psychology in the Collège de France; Vice-President, Charles Richet, professor of physiology in the Paris Faculty of Medicine; General Secretary, Pierre Janet, Director of the Laboratory of Psychology in the Collège de France. The seven Sections and the Presidents are as follows: (1) Psychology in its relations to physiology and anatomy, Professor Matthias Duval; (2) Introspective psychology and its relations to philosophy, Professor G. Séailles; (3) Experimental psychology and psycho-physics, M. A. Binet; (4) Pathological psychology and psychiatrie, Dr. Magnan; (5) Psychology of hypnotism and related questions, Dr. Bernheim; (6) Social and criminal psychology, M. Tarde; (7) Comparative psychology and anthropology, Professor Ives Delage. Those wishing to attend the Congress should apply to the Secretary, and those wishing to present papers should forward abstracts not later than January 1st, next.

THE Eighteenth Congress of the British Sanitary Institute will be held at Southampton from August 29th to September 2d, under the presidency of Sir William H. Preece. There will be three sections meeting for two days each, dealing with: (1) Sanitary Science and Preventive Medicine, presided over by Sir Joseph Ewart, M.D., F.R.C.P.; (2) Engineering and Architecture, presided over by Mr. James Lemon, M.Inst.C.E., F.R.I.B.A; (3) Physics, Chemistry and Biology, presided over by Professor Percy F. Frankland, F.R.S. There will also be special conferences of municipal representatives, port sanitary authorities, medical officers of health, medical officers of schools, engineers and surveyors to county and other sanitary authorities, veterinary inspectors and sanitary inspectors, and a conference on domestic hygiene.

Nature, quoting from the Allahabad *Pioneer Mail*, states that some important changes are being made in the meteorological department of the government of India. These comprise the abolition of a number of observing stations which have not proved worth keeping up, and the substitution for them of others in more favorable localities. Of the latter, most important are stations which are to be established at Cherapunji and one or two other places in Assam, which will enable a more careful watch to be kept over the meteorology of the tea districts, also regarding the periodical rise and fall of the rivers which are so important for the jute trade. Arrangements are also being made, but are not yet concluded, for the establishment of an observatory on Dodabatta Peak, the highest point in the Nilgiris, which is likely to be valuable in connection with the warnings of the monsoon.

ACCORDING to *The Medical Record*, a young man of Newport, Vt., a student of the University of Vermont, has brought suit against the professor of mathematics in the University for damages for the sum of $10,000. He says that he sustained an injury of the leg as the result of the taking of ten X-ray photographs of his leg soon after the bone had been fractured and while it was healing.

THE French naval authorities, acting in conjunction with Signor Marconi, on June 17th conducted some successful experiments with wireless telegraphy between a ship and the shore in the English Channel. We learn from the London *Times* that the French storeship *Vienne* was used for the purpose. One of Signor Marconi's installations was fitted up on board, and the inventor was present. Wimereaux, near Boulogne, and the South Foreland lighthouse, on the Kentish coast, were used as the land stations. Up to June 17th the distance between the South Foreland and Boulogne, about 28 miles, was the greatest space through which the messages have been transmitted. On June 17th messages were sent between the vessel and the English coast from off Boulogne, and afterwards at intervals, until the vessel was 12 or 14 miles away from that port. The greatest distance through which the messages were telegraphed were 42 miles. The increased distance appeared to have no effect, the messages being recorded at the receiving

station at the South Foreland with unvarying distinctness. The experiments began at 8 a. m., and were continued throughout the day. In the afternoon the Channel was enveloped in a dense fog, but this did not in any way interfere with the transmission of the messages. The vessel was fitted up with a wire passing up the masthead, and messages were exchanged while the vessel was travelling at various conditions of speed with the same result. An interesting feature in the experiments was the facility with which Signor Marconi's latest development for cutting out a station was applied. The messages were sent at will either to Wimereaux or to South Foreland, without the other station being able to intercept them. The results of the experiments are to be reported to the French government.

Consul Skinner, of Marseilles, under date of May 4, 1899, writes to the Department of State that reports from Algeria indicate that standing crops will be seriously damaged and in some cases destroyed by the clouds of grasshoppers now moving in a northerly direction. Ten thousand francs have already been placed at the disposal of the general of the division for the first expenses incurred in fighting against the invasion, and steps have been taken to secure $38,600 additional for the same purpose. Near Biskra 3,200 camels are being employed in the transportation of inflammable material which is being burned where deposits of eggs are found. In all parts of the colony men are at work plowing up eggs and destroying them. It is hoped that the energetic measuses being taken will prevent a now menaced catastrophe. The Algerian wheat crop of 1898 was estimated at 24,118,000 bushels. The exports of cereals from the colony during 1897 were as follows, in tons: Wheat, 54,178; corn, 971; barley, 33,492; oats, 32,781; flour, 2,826.

UNIVERSITY AND EDUCATIONAL NEWS.

We regret to learn that a decision, handed down by Judge Lacombe, reopens the Fayerweather will by which some five million dollars was bequeathed to educational institutions.

The Board of Visitors appointed to inspect the U. S. Naval Academy has handed in a report recommending the expenditure of $461,000 on buildings and land.

£10,000, half given by an anonymous benefactor and half appropriated from university funds, will be used for the erection of a pathological laboratory at Oxford.

Yale University, at its recent commencement, conferred 599 degrees as follows: B.A., 294; Ph.B., 136; C.D.S., 22; B.F.A., 2; LL.B., 65; M.D., 7; M.A., 34; D.C.L., 3; C.E., 1; M.E., 3; M.S., 2; Ph.D., 30.

The Rev. George Harris, D.D., professor of theology at the Andover Theological Seminary, has been elected President of Amherst College.

Chancellor MacLean, of the University of Nebraska, has been offered the presidency of the University of Iowa.

Dr. E. Benjamin Andrews has been reelected Superintendent of the Chicago public schools.

Dr. James Ewing has been appointed professor of pathology in the Cornell University Medical College, and in the University assistant professors have been appointed as follows: Dr. John Gifford in forestry, Dr. B. F. Kingsbury in histology and embryology, and M. V. Slingerland in entomology.

The following appointments and promotions have also been made: Charles W. Wardner, Ph.D. (Johns Hopkins), to be professor of physics in Williams College; H. G. Byers, Ph.D. (Johns Hopkins), to be professor of chemistry in the State University of Washington; Alfred H. Seal, Ph.D. (Pennsylvania), to be professor of chemistry in Girard College, Philadelphia; J. F. Collins, now curator of the herbarium in Brown University, to be instructor in botany; Howard Opdike, now instructor, to be assistant professor of mathematics at Union College; S. Alfred Mitchell, Ph.D. (Johns Hopkins), to be tutor in astronomy in Columbia University; Dr. Oliver L. Fassig, to be instructor in climatalogy in Johns Hopkins University, and Miss Robinson, of the University of Michigan, to be instructor in biology in Vassar College.

SCIENCE

FRIDAY, JULY 14, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*THE STRUCTURE OF PROTOPLASM.**

IT would be superfluous to dwell in this place on the deep and enduring interest that attaches to the microscopical study of protoplasm. Since the time when the studies of Cohn and Schultze led to the general recognition of protoplasm as the material substratum of vital activity—a conclusion so eloquently set forth by Huxley in his celebrated essay on the physical basis of life—this interest has continually increased, as we have come to see even more clearly that all biological phenomena are directly or indirectly traceable to the effects of protoplasmic activity, for we have thus been impelled to seek for an understanding of that activity in the morphological structure of protoplasm, as revealed by the microscope. It is small wonder that to this quest some of the ablest of modern biologists have devoted their best energies. And yet, if we take account of the actual

* This lecture is printed by permission of Professor C. O. Whitman, Director of the Biological Laboratory at Wood's Holl, and Messrs. Ginn & Co., the publishers of 'Biological Lectures delivered at the Marine Biological Laboratory, 1889–99,' in which it will appear. A more adequately illustrated special paper on the subject, containing more specific references to the literature, is now in press. It should be borne in mind that such delicate textures as those seen in the protoplasm of living cells cannot be properly illustrated by black and white figures. The accompanying text figures, though copied as accurately as possible from the original drawings, are of necessity relatively rude and schematic.

knowledge gained, we cannot repress a certain sense of disappointment, partly that microscopical research should have fallen so far short of giving the insight for which we had hoped, but still more because of the failure of the best observers to reach any unanimity in the interpretation of what is actually visible under the microscope. In any consideration of the general subject, therefore, it is well to keep clearly in view the fact that such disagreement exists, and that we are not yet in a position to justify any very certain or far-reaching conclusions.

I would like, at the outset, to express the opinion that, if we except certain highly specialized structures, the hope of finding in visible protoplasmic structure any approach to an understanding of its physiological activity is growing more, instead of less, remote, and is giving way to a conviction that the way of progress lies rather in an appeal to the ultra-microscopical protoplasmic organization and to the chemical processes through which this is expressed. Nevertheless, it is of very great importance to arrive at definite conclusions regarding the visible morphology of protoplasm, not only because of its intimate connection with all the problems of cell-morphology, but also in order to find the right framework, as it were, for our physiological conceptions, and thus to gain suggestions for further physiological and chemical inquiry. And this must be my excuse for reviewing a subject which is still so largely obscured by doubt, and of which the outcome gives, after all, so little satisfaction.

It is especially important in this field of biological inquiry to distinguish clearly between theory and observed fact, for theories of protoplasmic structure have always far outrun the actual achievements of observation. From the time of Brücke (one of the first to insist that protoplasm must possess a far more complicated organization than that visible under the microscope) speculation has gone steadily forward, to reach, perhaps, its most elaborate expression in Weismann's interesting, but unconvincing, work on the germ-plasm—an elaborate speculative system built out of hypotheses which, for the most part, float in the air without visible means of support. We need not consider this side of the subject *in extenso*, but I will ask attention, for a moment, to what is the most characteristic and, to the morphologist, the most interesting point in these speculations, namely, the doctrine of genetic continuity as applied to the corpuscular, or micellar, theory of protoplasm. We are all familiar with the successive steps by which that doctrine gradually developed. Harvey's celebrated formula, *ex ovo omnia*—or, as usually quoted, *omne vivum ex ovo*— took with Redi the far more philosophical form, *omne vivum e vivo*, thus expressing a truth which forms the very foundation of all biological teaching at the present day. The development of the cell-theory, long afterwards, enabled Virchow to pronounce the more specific aphorism, *omnis cellula e cellula* (1855), a statement involving the highly interesting conclusion that protoplasm is never formed *de novo*, but always arises from or through the activity of preëxisting protoplasm differentiated into the form of a cell. Still later a like conclusion was reached with respect to at least one of the structural components of the cell, namely, the nucleus, and the work especially of Flemming and Strasburger justified the saying, *omnis nucleus e nucleo*. Not long afterwards, the researches of Schmitz, Schimper and others showed that in plant cells some, if not all, forms of plastids (for example, the chlorophyll-bodies) likewise arise by the division of preëxisting bodies of the same kind. Thus the law of genetic continuity was gradually extended downwards from the grosser and more obvious characters of the organism

into the finer details of its structural elements. Genetic continuity, the origin of like from like, may now safely be regarded as a demonstrated fact in the case of all existing organisms and of all cells; it hardly falls short of the same degree of certainty as applied to the nucleus; it is probable in the case of various forms of plastids in plant cells; while the centrosome is now being weighed in the balance with the evidence for the moment apparently accumulating on the negative side.

Up to this point we have been dealing with matters of observed fact. The next and final step was, however, taken in the region of pure speculation, which had in the meantime been at work building upwards from hypotheses regarding the basic composition of protoplasm. Brücke's suggestion, that the cell might be a congeries of bodies more elementary than itself, found a much fuller expression in Herbert Spencer's theory of physiological units; but it was Darwin's theory of pangenesis that laid the real basis for what followed in the works of De Vries, Wiesner, Weismann and Hertwig. The common feature in all these later views is the conception of protoplasm, not as a homogeneous substance or mixture of substances, but as made up of a host of elementary ultra-microscopical corpuscles ('pangens,' 'biophores,' etc.), specifically different, capable of assimilation, growth and multiplication, and arising by division of preëxisting bodies of like kind. Developed as a purely theoretical hypothesis, and within somewhat narrower limits by Darwin, this conception was expanded and brought into more direct relation with observed fact, especially by De Vries and Wiesner, who showed how the assumption of such elementary self-propagating corpuscles at the basis of living matter enabled us to bring all the observed phenomena of genetic continuity under a common point of view. The fundamental hypothesis itself —*i. e.*, the genetic continuity of the ultimate morphological units —has, however, always remained, and still remains, a pure assumption, incapable of direct proof or disproof; for, with the exception of Altmann and a few of his followers, all are agreed that such elementary corpuscles, if they exist, must lie beyond the limits of microscopical vision. Altmann, however, has sought to identify the elementary units, or 'bioblasts,' with the visible protoplasmic granules; and, in his writings, the series of Latin aphorisms initiated by Redi culminates in the saying, *omne granulum e granulo* (!), but this conclusion has not been taken very seriously by most other investigators.

I have given this very brief sketch of the theoretical side of the question merely as an introduction, and shall dwell no farther on it at this point, since my main purpose is to ask attention to the visible, as opposed to the hypothetical invisible, structure of protoplasm. A subject so vast, displaying so great a conflict of opinion, must be very briefly treated within the limits of a single lecture; and I shall, therefore, confine the discussion in the main to the protoplasm of the echinoderm-egg, which is accessible to every one, has been made a classical object through the studies of such leaders of research as Flemming, Bütschli and Hertwig, and illustrates as clearly, perhaps, as any other the various interpretations of protoplasmic structure that have been given.

In thin sections of well-preserved material the protoplasm of a star-fish or sea-urchin egg gives the appearance, under a high power, of a fine meshwork or framework composed of innumerable minute granules, or *microsomes*, suspended in a clearer, less deeply staining, continuous substance (Figs. 1, *a*, and 4). The spaces of the meshwork, which measure from one to nearly two microns, are occupied by a third substance, clear, homogeneous, and

of only slight staining capacity, which has often been called the *ground-substance*. During cell-division the meshwork in the neighborhood of the dividing nucleus assumes a radiating appearance, giving rise to the so-called asters, or astral systems which are typically double, forming the *amphiaster* (Fig. 3, *b*). We may define the

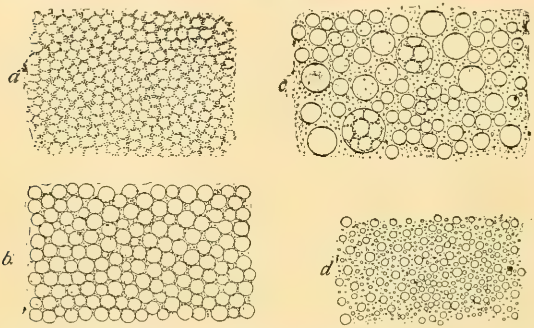

FIG. 1. (*a*) Protoplasm of the egg of the sea-urchin (*Toxopneustes*) in section; (*b*) protoplasm from a living star-fish egg (*Asterias*); (*c*) the same in a dying condition after crushing the egg; (*d*) protoplasm from a young ovarian egg of the same. (All the figures magnified 1,200 diameters.)

problems suggested by these appearances by a series of questions as follows:

1. What is the actual structure that gives the appearance of a meshwork?

2. How faithfully does the preserved structure, as seen in sections, reproduce that existing in life?

3. What is the relation of the astral systems to it?

4. What is the finer structure and origin of the meshwork?

5. Can this structure be taken as typical of all protoplasm; and if not, what is its relation to other forms of protoplasmic structure?

After seeking for answers to these queries, we may finally inquire how they bear on the theoretical views briefly reviewed above. Incidentally, still another interesting question arises, namely: Is it possible to identify any one of the three elements in question—granules, continuous substance, ground-substance—as the *living* substance or *protoplasm* proper, as distinguished from a lifeless *metaplasm*, and, if so, what are its structural relations?

Could we positively answer all these questions we should have taken a long step forwards in the study of the cell. Far from this, however, in point of fact, hardly any two observers have given exactly the same answers to them. Leaving aside the earlier views, we find in the recent literature of the subject two principal general views with a number of modifications of each.

The first of these agrees with the early view of Klein and Van Beneden, that the protoplasm forms a net-work, *reticulum*, or thread-work, composed of branching fibers embedded in a homogeneous ground-substance which fills the interstices of the network, and with granules or microsomes lying along the course of the threads or at the nodes of the network. Many of those who adopt this interpretation further agree with their predecessors that the astral systems formed during cell-division arise directly through a rearrangement of the preexisting network, about active centers of attractive or other forces, somewhat as iron-filings arrange themselves along the radiating lines of force in a magnetic field—an arrangement which bears a remarkably close though only superficial resemblance to the protoplasmic amphiaster. Boveri and some others, however, regard the astral system as having no direct relation to the preëxisting network, believing that the rays either arise from a specific substance ('ar-

choplasm'), distinct both from the general network and from the ground-substance, or are wholly new formations which, as it were, crystallize afresh out of the protoplasmic substance.

The second view is that of Bütschli, who believes it to be applicable to all forms of protoplasm, and who has been followed by a considerable number of recent investigators. Bütschli's interpretation differs entirely from the foregoing, the meshwork being regarded not as a network, but as an appearance resulting from the optical section of 'alveolar' or emulsion-structure. The spaces of the meshwork are drops of liquid occupying spherical spaces, or 'alveoli'; the 'fibers' are optical sections of the thin layers, or lamellæ, by which the drops, or alveoli, are surrounded. Even the astral systems receive the same interpretation, the astral 'rays' and 'spindle-fibers' being an optical illusion resulting from the radial arrangement of the alveoli, and hence of the inter-alveolar septa by which they are separated.

The greater number of observers of protoplasm have given their adherence to one or the other of the two widely dissimilar views just outlined, though there are others to which we shall return later. Some investigators have taken a position intermediate between these two extremes. Thus Reinke has maintained that the cytoplasm of the echinoderm-egg is alveolar, as described by Bütschli (though, as will appear beyond, he ascribes to this structure a different physiological interpretation), while the astral systems are fibrillar, as held by Van Beneden, and arise as new formations at the cost of the alveolar walls. More recently, Strasburger has developed the related, but still different, view that the cytoplasm of the cell at large consists of two distinct substances, namely, the *trophoplasm*, or general nutritive plasma, which is alveolar, and the *kinoplasm*, or the substance active in division, which is fibrillar and gives rise to astral systems consisting of true rays and fibers.

It is remarkable that the best observers, working in many cases at the same object, should have reached conclusions so diverse. It is obvious, further, that in the face of such contradictions it is impossible to give any discussion of the subject that is not more or less strongly tinged with the personal views of the writer. Such views, by whomsoever expressed, can at present have no more than a provisional value; and this is the last subject on which dogmatism should be allowed. It is with full recognition of these difficulties that I venture to state some of my own conclusions, partly because they may serve to explain, in some measure, to those who have not specialized in this field, how the existing diversity of opinion has arisen, partly because they have perhaps some bearing on the more general questions that were referred to at the outset. I shall take up in order the questions raised above.

The Nature of the Meshwork.—Although in earlier papers I was inclined to regard the meshwork of the echinoderm-egg as a reticulum, further studies have left no doubt whatever, in my opinion, that in the resting cell it is in reality an alveolar structure—or, as I do not hesitate to call it, an *emulsion*—such as Bütschli has described. I was first led to this conclusion through the study of sections of the eggs of sea-urchins (*Toxopneustes*) and star-fish (*Asterias*); but whatever doubt may have remained was completely dissipated by the study of the living eggs of *Asterias* (Fig. 1, *b*), *Echinarachnius*, *Arbacia*, *Ophiura* (Fig. 2, *a*), under high powers. All of these eggs give in life essentially the same appearance, though no two are exactly alike. In all, the protoplasm consists of innumerable closely crowded minute spheres suspended in a clear basis. The spheres may be called the alveolar spheres, or, more

briefly, the *alveoli,* though, strictly speaking, the latter term should designate the cavities which the spheres fill. The clear basis in which they lie, and which forms the inter-alveolar walls, may, with Mrs. Andrews, be called the *continuous substance.* Scattered about in the walls are numerous granules, or *microsomes,* far smaller than the alveoli, which often give the appearance of an irregular network. If now we compare these appearances of the living protoplasm with those seen in the sections mounted in balsam we find at first sight very considerable differences. More critical study shows, however, that the differences are almost wholly due to the effect of differential staining and to the difference of refractive index in the mounting media in the two cases. The alveoli of the living protoplasm form the spaces of the meshwork. The latter consists of the continuous substance with the granules suspended in it. In the section what especially strikes the eye is the meshwork; for the alveolar spheres do not stain, and their contours become indistinct in the highly refracting balsam, while the continuous substance stains slightly, and the granules intensely, thus giving the appearance of a conspicuous granular meshwork. We thus arrive at a definite answer to two of the questions propounded above, namely: (1) the meshwork shown in sections is not a network, but the expression of an alveolar or emulsion-structure, and (2) proper fixation does not produce a mass of coagulation-artefacts, but preserves the visible structure very nearly as it exists in life.

The above conclusions are based mainly on the study of star-fish eggs, but are confirmed by the facts observed in other forms. In *Arbacia* the emulsion is considerably finer, the alveoli measuring on an average no more than 1.0 micron, while the finer granules are relatively less numerous. The pigment-granules characteristic of this form appear to be nothing other than modified alveolar spheres. In *Toxopneustes* the alveoli measure approximately from 1.0 to 1.3 microns, while the granules are more numerous than in *Asterias.* In *Echinarachnius* the alveoli are less uniform in size than in *Asterias,* the largest measuring up to about 1.7 microns, while the granules are less numerous. The egg of *Ophiura,* finally, has an extremely coarse structure, the alveolar spheres measuring on an average 3.0 to 4.0 microns, while the granules, or microsomes, are also very large and, in the superficial layers of the protoplasm, even more numerous than in *Toxopneustes.* The protoplasm of *Ophiura* (Fig. 2) is highly favorable for study, not only on account of the great size of its elements, but also by reason of the remarkable fact that these elements are colored in life, the alveolar spheres being in most individuals distinctly of an olivaceous or pinkish-brown color, while

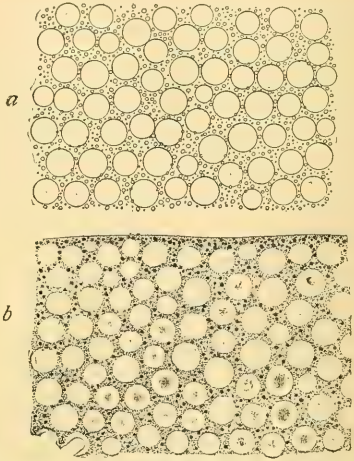

FIG. 2. (*a*) Protoplasm from a living ophiuran egg (*Ophiura*), slightly compressed, so as to spread the yolk-spheres somewhat apart; *b* the same as seen in a section (sublimate-acetic, iron-hæmatoxylin; 1,200 diameters).

the larger granules, or microsomes, are lemon yellow. This circumstance makes possible an observation of great importance, namely, that *all the elements of the protoplasm are liquid or viscid.* If the eggs of *Ophiura* be crushed by pressure on the cover-glass the protoplasm flows out, most of the alveolar spheres going in advance, while the granules and continuous substance lag behind. Meanwhile, the alveolar spheres often run together to form larger drops of all sizes, the origin of which is placed beyond question by their color. The same is true of the yellow microsomes, though this takes place less readily, and only under somewhat rough treatment. This demonstrates the liquid, or at least viscid, nature of both the spheres and the microsomes, and no less certainly that of the continuous substance in which both lie. As far as the alveolar spheres are concerned, the same observation may readily be made in the colorless protoplasm of *Asterias* (Fig. 1, *c*), *Echinarachnius*, or *Arbacia*, but I could never satisfy myself of the liquid nature of the microsomes in these forms. The case of *Ophiura* renders it highly probable, however, that the granules are liquid in these forms also—a conclusion which I confess was a surprising result to me; for we are so accustomed from our studies on sections to regard the granules as solid bodies that we are apt to forget that sections show us only coagulated material.

To sum up, a critical study of the living protoplasm of echinoderm-eggs shows that it is a liquid, or rather a mixture of liquids, in the form of a fine emulsion consisting of a continuous substance in which are suspended drops of two general orders of magnitude and of different chemical nature, as indicated by their staining reactions. The larger drops, forming the alveolar spheres, stain only slightly in hæmatoxylin, and constitute the so-called 'ground-substance' in the spaces of the meshwork; these have an average size, ranging in the various forms studied from 1.0 micron or less (*Arbacia*) up to 4.0 microns (*Ophiura*). The smaller drops, forming the granules or microsomes, are very much more minute, and stain intensely with iron-hæmatoxylin. The presence of the larger drops determines the primary alveolar structure as described by Bütschli. The smaller drops ('granules') lying between these give rise to the 'secondary,' or finer alveolar, structure as described by Reinke, and subsequently by Mrs. Andrews, as I understand these authors.

Relations of the Astral Rays to the Meshwork.—We may now make a brief digression to consider the third question propounded above, namely: What is the relation of the astral rays and spindle-fibers to the alveolar substance? It is easy to see, both in sections and in living material, that in a well-developed aster the alveoli are arranged in radiating lines between the astral rays (Fig. 4), precisely as Bütschli and so many others have described. The rays themselves are, however, something more than the radially arranged inter-alveolar septa, for, in the first place, they are often much thicker than these septa, and, in the second place, they stain more intensely than the continuous substance. A careful study of the rays in the echinoderms, and in many other forms (especially in *Nereis*, *Thalassema*, *Lamellidoris* and *Ascaris*), leaves, I think, no room for doubt that, in sections at least, the rays are actual branching fibrillæ, as described by so many observers since the time of Van Beneden, that thread their way through the continuous substance between the alveoli, often in a zigzag course. The strongest evidence that they are fibrillæ is given by the appearance of the cut ends of the rays as they appear in somewhat excentric or rather thick sections of the asters. In such sections, particularly in the case of large and coarse asters like those of *Nereis* (Fig. 3, *b*), the rays may be

seen in the clearest manner to terminate as they pass upwards towards the eye in well-defined cut ends, and I think no one who studies these preparations can doubt that in them the asters are true fibrillar structures.

We may now inquire in what manner the rays arise and grow, and what is the origin of their substance. In the growing aster

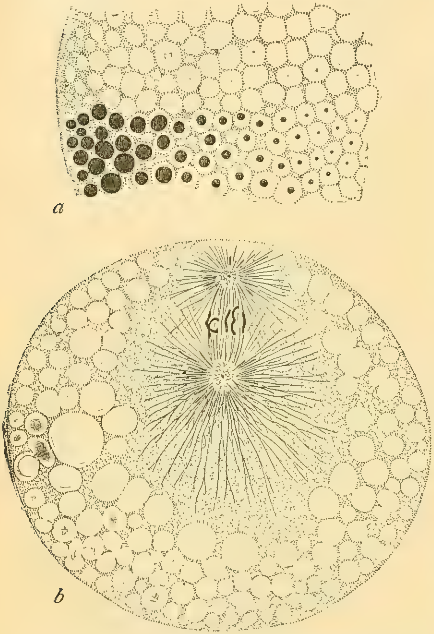

FIG. 3.—(*a*) Protoplasm and yolk-spheres from the egg of *Thalassema* in section. The upper part of the section shows the result of prolonged extraction of the dye (iron-hæmatoxylin); the lower half represents varying degrees of extraction (1,200 diameters); (*b*) egg of *Nereis* in section showing yolk-spheres and the first polar amphiaster above (600 diameters).

the rays progressively extend themselves from the center outwards, gradually losing themselves in the general meshwork. It has been maintained by some writers that the rays grow outwards from their bases like the roots of a plant, and in a certain sense this is undoubtedly true. But it is difficult to believe that all of the material of the rays comes from the base, *i. e.*, from the nucleus or the centrosome, for they often extend themselves throughout the entire cytoplasm, even in cases where, as in the sperm-aster of echinoderms, the center of the aster remains very small, and the nucleus still consists of a compact mass of chromatin (Fig. 4). It is more probable that they grow at the tip, continually extending themselves at the cost of the material lying in the meshwork. When the rays are followed out peripherally they may often be seen to run out into rows of granules like beads on a string. Van Beneden, who has been followed by many later writers, was inclined to regard the rays as essentially rows of microsomes strung together by a homogeneous, clear substance, *i. e.*, by the continuous substance, and I was led to the same conclusion in the case of sea-urchin eggs. A study of the asters in *Ophiura* throws doubt upon this conclusion, for it is here certain that the larger and deeply staining microsomes do not build up the ray, but are quite irregularly scattered along its course. The rays here mainly arise, I believe, in, and at the expense of, the continuous substance, and the linear arrangement of the microsomes is incidental to the differentiation of this substance along a definite tract which more or less involves the microsomes as it progresses. This conclusion probably also applies to other forms. The material active in the ray-formation appears to be the continuous substance, and, while the microsomes may, and probably in many cases do, contribute to the ray, they probably play the part of reserve material rather than of active elements.*

* As already pointed out, we cannot assume that the ray is *merely* an accumulation of the continuous substance on account of its different staining capacity.

To sum up, the general result indicates that the opinions regarding the aster-formation referred to above can in a measure be reconciled. In the case of echinoderm-

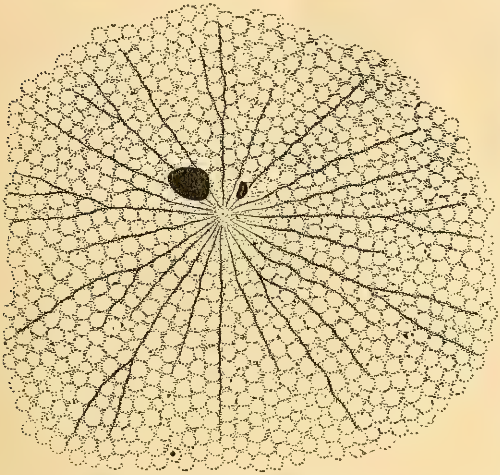

FIG. 4.—Section of sea-urchin egg (*Toxopneustes*), $1\frac{1}{2}$ minutes after entrance of the spermatozoön, showing sperm-nucleus, middle piece and aster (about 2,000 diameters).

eggs Bütschli and Erlanger correctly describe the aster as involving a radial arrangement of the alveoli, but they have failed to recognize the fibrillæ that lie between them, and Boveri is, therefore, thoroughly justified in the contention that the astral systems cannot be regarded as merely a radial configuration of the preëxisting meshwork. I, nevertheless, think that Hertwig, Reinke and myself were right in the contention, which has been made also by many others, that the rays grow by progressive differentiation out of the general cytoplasmic meshwork, and that there is no ground, in the echinoderm-egg at least, for the recognition of a specific 'archoplasm' or 'kynoplasm' from which they arise.

Finer Structure and Origin of the Meshwork.—We may now consider what is, I think, the most suggestive of the questions propounded, namely, that relating to the finer structure and origin of the mesh work. We have thus far distinguished sharply between alveolar spheres, granules, or microsomes, and continuous substance. Morphologically considered, however, there is good reason for the view that all these are but different gradations of one structure. In the first place a nearly or quite complete series of size gradations exists between the largest alveoli and the microsomes (Fig. 1, *b*, *c*). Although most of the alveoli vary but slightly in size from the mean, a little search shows the presence of many smaller ones, and here and there they seem almost, if not quite, as small as the larger microsomes. In the second place, careful study of the 'continuous' substance in life, especially in the crushed protoplasm, shows that the larger microsomes in turn graduate down to granules so small as to lie near or at the limit of microscopical vision. The 'continuous' substance is, in other words, filled with granules, *i. e.*, drops of all sizes, ranging from the smallest visible ones up to the largest alveoli. It is this fact which Mrs. Andrews, as I understand her statements, has in view in maintaining that the coarser alveolar structure "is not, indeed, the final structure of the living substance, but is part only of an infinitely graded series of vesiculations of the protoplasmic form" and with this statement I entirely agree. But we cannot stop here. Irresistibly the further question suggests itself: Why should we place the end of this series at the end of microscopical vision

under a 1.5 mm. immersion objective—which is, of course, a perfectly arbitrary and artificial limit? It is impossible to doubt that powers still higher than any at our command would reveal the existence of granules still smaller, and that what appears as 'continuous' or 'homogeneous' substance is itself an emulsion beyond the range of vision.

We may now inquire whether the coarser visible alveolar structure is characteristic of all protoplasm. This question has in a measure already been answered, for in these very eggs we have seen the alveolar structure giving rise to a fibrillar one in the aster-formation—in other words, the protoplasm of the same cell may in different phases pass back and forth from one state into another. This fact appears in its clearest form when we study the growth of the ovarian ova, which gives us many additional suggestions of high interest. *The entire coarser alveolar structure, as described above—i. e., the foam structure of Bütschli—is in these eggs of secondary origin.* The very young living ovarian eggs consist of 'homogeneous' protoplasm, such as has been described by many botanists in the embryonic tissue-cells, through which are irregularly scattered a few small spheres and many excessively small granules. As growth proceeds both the spheres and the granules increase in size, the latter enlarging to form new spheres, while new granules continually emerge from the protoplasmic background into the limits of vision. In the middle stages of growth the protoplasm is thus converted into an emulsion, being filled with spheres of all sizes, ranging downwards from 1.0 micron to the smallest granules, but still showing no regular arrangement (Fig. 1, *d*). As the egg approaches maturity the spheres become differentiated into two groups, the larger ones becoming approximately of the same size, to form the alveolar spheres and crowding together, while the smaller ones remain as the microsomes and finer granules embedded in the remains of the continuous substance which forms the basis of the meshwork. In one sense, therefore, the alveolar spheres and the microsomes are only different stages in the same morphological series—though it should be remembered that they differ chemically as well as in size, and I do not mean to imply that the one may develop into the other—and both the alveolar and the fibrillar or reticular structures in these eggs are of secondary origin. If this be the case neither of these types of structure can be of fundamental importance; and I fully agree with the opinion of Kölliker, which has been adopted by an increasing number of later observers, that *no universal or even general formula for protoplasmic structure can be given.* The evidence indicates that alveolar, granular, fibrillar and reticular structures are all of secondary origin and importance, and that *the ultimate background of protoplasmic activity is the sensibly homogeneous matrix or continuous substance* in which those structures appear.

I do not mean to say that this is the only 'living' element in the cell. The distinction between 'living' and 'lifeless,' between 'protoplasmic' and 'metaplasmic,' substances is exceedingly difficult to define —largely on account of our vague and inconsistent use of terms, for in practice we continually use the word 'living' to denote various degrees of the vital activity. Protoplasm deprived of nuclear matter has lost, wholly or in part, one of the most characteristic vital properties, namely, the power of synthetic metabolism; yet we still speak of it as 'living,' because it may for a long time perform some of the other functions, manifesting irritability and contractility, and showing also definite coördinations of movements (as in the enucleated protozoan); and, in like manner, various

structural elements of the cell may be termed living in a still more restricted sense. In its fullest meaning, however, the word 'living' implies the existence of a group of cooperating factors more complex than those manifested by any one substance or structural element in the cell, and I am, therefore, thoroughly in accord with those who have insisted that life in its full sense is the property of the cell-system as a whole rather than of any one of its separate elements. Nevertheless, we are perhaps justi- in maintaining that the continuous substance is the most constant and active element, and that which forms the fundamental basis of the system, transforming itself into granules, drops, fibrillæ or networks in accordance with varying physiological needs.*

Whether any or all of these elements are 'living' or 'lifeless' depends largely on the sense in which these words are used; and it is well, therefore, to follow the example of Sachs, in substituting for these words, as applied to special structural elements of the cell, the terms 'active' and 'passive,' which properly admit of degrees of comparison. The distinction between 'protoplasmic' (active) and 'metaplasmic' or 'paraplasmic' (passive) elements, though a real and necessary one, thus becomes, after all, one of degree only.

We are thus brought to consider another point of some interest suggested by the comparative study of the facts described above. Bütschli states that in the true or finer alveolar structure, characteristic of protoplasm in general, the alveoli do not measure more than 2.0 microns, and as a rule are considerably smaller. This, he insists, is not to be confounded with a 'coarser vacuolization,' characterized by larger drops or spheres, which may secondarily arise in the finer structure. Again, Reinke and Waldeyer, in a somewhat similar manner, characterize as 'pseudo-alveolar' a structure arising secondarily through the deposit of passive metaplasmic products of metabolism, such as yolk-spheres, fat-drops and the like, in the living protoplasmic basis. Both distinctions break down, I think, in the light of the foregoing facts. In most of the forms considered—*Arbacia*, *Toxopneustes*, *Echinarachnius*, *Asterias*—the alveolar spheres are considerably less than 2.0 microns (1.0 to 1.7), and the structure is, therefore, a true alveolar one in Bütschli's sense; indeed, Bütschli himself describes and figures the protoplasm of the *Sphærechinus* egg as an example of that structure. In *Ophiura*, however, the spheres measure up to 3.0 to 4.0 microns, and are undoubtedly 'yoke-spheres' in the usual sense. It is, however, quite certain, from the ovarian development of these eggs, that they differ from the others only in degree, and that Bütschli's criterion of size gives no satisfactory ground for any real distinction. The alternative is to regard all the forms as pseudo-alveolar, irrespective of the size of the alveolar spheres, which are in all cases to be regarded as metaplasmic bodies; and this is the view which Reinke specifically applies to *Sphærechinus*. But if this view be adopted we seek in vain for any ground of distinction between such a fine 'pseudo-alveolar' structure as that of *Arbacia* and the 'true' alveolar structure of tissue cells, and are forced to the conclusion that in the latter case also the alveolar substance consists of passive or metaplasmic material —a view which has, in fact, been adopted by some writers. For my part, I am convinced that the entire distinction is without adequate basis, and that no definite boundary-line can be drawn between even the

* It is hardly necessary to state that this view is not original, except in so far as it has been directly suggested by the observations described above; for it has been more or less definitely maintained by many others, and I am only expressing what seems to be a growing opinion among workers in this field.

largest deutoplasm-spheres, vacuoles or other metaplasmic deposits, the alveolar spheres of *Arbacia* or *Toxopneustes* and those occurring in tissue-cells; and probably all are, in the sense indicated above, to be classed among the relatively passive or metaplasmic material.

How generally the alveolar, reticular or fibrillar formations may occur is a matter still to be determined by observation. It is probable that the alveolar structure will be found to be of more general occurrence than has been supposed; and, judging by the appearance observed in echinoderm and other eggs, and in coagulated albumen and other structureless proteids, I suspect that some cases of so-called 'reticular' formations will be found to arise through the more or less imperfect fixation of the alveolar, leading to the coagulation, contraction and breaking down of the alveolar walls,* though I do not for a moment mean to imply that such is the case with all reticula.

What light, if any, do the foregoing general conclusions throw on the theoretical views outlined at the beginning of this lecture? The answer must be: None that is clear and satisfactory, for the background of all the phenomena appears to lie in the invisible organization of a substance which seems to the eye homogeneous. Yet there is, I think, much in these conclusions to suggest, and nothing to contradict, the hypothesis that the 'homogeneous' or 'continuous' substance may be composed of ultramicroscopical bodies, by the growth and differentiation of which the visible elements arise, and which differ among themselves chemically and otherwise, as is the case with the larger masses to which they give rise. I will not enter upon a discussion of the question whether these bodies are merely molecules, more or less complex, or groups of molecules forming protoplasmic units or micellæ, but will only make three suggestions: First, if such units exist, they cannot be identified with the visible granules or 'bioblasts' of Altmann, but are bodies far smaller. Second, if there be any truth in what has been said above regarding the localization of 'living' matter in the cell, such protoplasmic units, if they exist, cannot properly be called 'biophores,' since life is a manifestation of the system which they form, and not of the individual units. The corpuscular, or micellar theory of protoplasm, as an hypothesis of morphological organization, should not be confounded with the physiological theory that biophores or pangens are 'elementary living units.' Third, by ascribing to these hypothetical units the power of growth and division, in accordance with the pangen theory, we are enabled to get a certain amount of light upon some of the most puzzling questions of cytology, such, for example, as the ultimate nature and origin of dividing cell-organs like the nucleus or the plastids, and especially such a contradiction as that presented by the centrosome, which may apparently arise either *de novo* or by division of a preëxisting body of the same kind. As De Vries and Wiesner have so suggestively urged, the power of division on which the law of genetic continuity rests and which is manifested by morphological aggregates of so many different degrees, may have its root in a like power of the primary units at the bottom of the series, out of which all the higher members are built. But while giving due weight to this suggestive hypothesis, we may question whether its acceptance does not introduce as many new special difficulties as those which it sets aside; while we must admit that it leaves untouched the fundamental problem of division. The solution of this problem may perhaps have to be sought in

* It may be well to point out that Rhumbler has produced true fibrillar and reticular formations in coagulated artificial gelatine-emulsions.

a quite different direction from the pangen hypothesis. Whether we shall succeed in finding it is another question.

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PICTURES IN THREE DIMENSIONS.

A CHICAGO publishing firm has put on the market a series of pictures in which a stereoscopic effect is produced by a device which seems not to have been used before in this country, but which is well known in Germany. Two photographs of an object are taken at distances apart equal to the distance between the eyes, and with objectives whose focal lengths are equal to the distance of distinct vision—that is, in the ordinary manner of making stereoscopic pictures. These two pictures are printed in two different colors, say red and green, so as to nearly but not quite overlap each other, and they are then looked at through spectacles composed of red and green glass. If the red picture is to the right and the green picture to the left, then the right eye looks through a green glass and sees in strong *black* the picture which is printed in red, but overlooks the faint green picture by the side of it; at the same time the left eye looks through a red glass and sees in sharp black outlines the picture which is printed in green, but not the faint red shadow at the side of it. In this way are produced the two halves of a stereoscopic impression, and a very good illusion of relief is obtained.

That the explanation above given is the correct one is proved by the fact that the images of near objects are plainly farther apart than those of distant ones ; that if one looks attentively, with the glasses on, one can see the shadowy secondary pictures at the right and left of the principal one ; that by putting on the spectacles wrong side up an inversion of the relief is obtained—near objects look far and far objects look near, so far as this is not interfered with by other elements of solid vision, as perspective, shadows, overlapping, etc., and that, by inverting the picture as well as the spectacles, the correct relief is again obtained; and, finally, by the fact that when one sees single an object in the foreground, one is evidently not fixating upon the plain of the paper, because the title of the picture, in plain black lettering below, is then perceived to be doubled.

The pictures of this issue are roughly made, and while the illusion is very strong it is not at all perfect ; the distance between a child in the foreground and a building in the background will be, for instance, very distinct, but the child will be itself rather flat. With better workmanship, this method for securing vision in the third dimension ought to have an important future. The stereoscope has, for some reason, never lent itself to the purposes of art; this process, which has much less paraphernalia, and hence has its mechanicalness much less in evidence, may conceivably fill a more important rôle in this respect. However that may be, its usefulness for scientific purposes ought to be very great. There are countless intricate things which one desires extremely to represent in their solidity, and which it is unnecessarily hard for the reader to catch the bearing of when they can only be seen in the flat. Think for a moment how great would be the difficulties of the student of geometry if he had no more lifelike representations of his plane triangles than he has of his polyhedra and his parallelopipedons, and then imagine the pleasures that are in store for him if he has only to pick up his red and green spectacles to see the figures of solid geometry in all the reality which has hitherto existed for him only in the plane ! And what rapid progress will be made in the imaginings of the stereo-chemist when he is given this ma-

terial aid to the construction of his right-handed and left-handed molecules! It is strange that more use has not been made of the ordinary stereoscope for purposes of scientific illustration; instead of having expensive models of the forms of higher mathematics, every purpose would be subserved if a set of stereoscopic views of them were provided. With this new and more simple device there is every reason to hope that representation in the solid, requiring merely that a person should take his red and green glasses out of his pocket, will become nearly as much a matter of course as plain, or rather plane, diagrams are now.

Another field for the application of this principle is in illustrations thrown on the screen for large audiences. There would be no difficulty whatever in projecting one picture of a stereoscopic pair through a red glass on to the screen, and the other through a green glass, and providing the onlookers with the corresponding spectacles; this, in fact, is the special form of the process which is already in use in other countries. For this form, as well as that on a card for individual use, stereoscopic pictures already made need only to be reproduced in the proper colors to answer the requirements of this new method.

As regards the painter of pictures in the artistic sense, it is perhaps prophetic that he has already furnished his paintings strong purple shadows; he has only to intensify the greens on the *other side* of his trunks of trees, and to provide the necessary green and purple glasses for his critics, in order to show them a picture of reality, such as he has before only dreamed of producing.

The process ought, therefore, to have an important future. The present publisher in the Redheffer Art Publishing Co., Baltimore Building, Chicago.

C. Ladd Franklin.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

BOTANY.

It is manifestly quite impossible to-day to make a satisfactory schedule of the classification of botanical books and papers for use in libraries, since, to be satisfactory to the botanists, it should represent the present development of the science, while, on the other hand, such a representation would be far beyond the technical botanical knowledge of the librarians. It is the misfortune of Science that much of its administration must be entrusted to persons who have, at the best, only a general knowledge of the subject, and this very often representing an old phase of the science, long since abandoned in the laboratory and lecture-room. It is, perhaps, impossible to have it otherwise, at least for a long time to come; we cannot require librarians to know as much in regard to the progress of Science as the workers themselves. It is inevitable, therefore, that any scheme of the classification of botanical books which can be used by librarians must fall considerably short of representing the present condition of the science. On the other hand, as revisions of library schemes are made from time to time, it is desirable that the classification should be brought forward somewhat nearer the present condition of Science, as far, at least, as can be done with safety, since no library, by its inertia, should become, to a marked degree, the conservator of abandoned scientific views.

The International Catalogue Committee apparently have kept in mind something like the foregoing, and have wrought out a scheme which will no doubt be workable by librarians and those whose knowledge of Botany is general rather than specific. Probably few, if any, objections will be brought against it by the librarians and general students of plants, at least in so far as the general plan is concerned. We may,

however, look for objections from the specialists whose work has carried them far beyond the somewhat old-fashioned grouping of subjects here adopted, and it becomes our duty to inquire whether or not it is advisable at this time to still further modernize the classification proposed.

The primary divisions made by the committee are as follows:

I.—Bibliography (including philosophy, history, biography, dictionaries, text-books, pedagogy, addresses, lectures, essays and works on method.

II.—External Morphology and Organogeny (including this consideration of the vegetative and reproductive organs, alternation of generations, and teratology).

III.—Anatomy, Development and Cytology (including this consideration of the vegetative and reproductive organs, embryology, anatomy and development of tissues and cytology).

IV.—Physiology (including the physiology of (*a*) the vegetative organs and (*b*) the physiology of reproduction).

V.—Pathology (including diseases due to malnutrition, to other plants, to animals, to other or unknown causes, wounds, reparative processes, galls, treatment of diseases).

VI.—Evolution (including heredity, variation, natural and artificial selection, degeneration, phylogeny).

VII.—Taxonomy (including general works on systematic botany, nomenclature, etc., and those relating to plants falling under any of the great plant groups from Dicotyledons down to Bacteria and Mycetozoa).

VIII.—Geographic Distribution (including general works, local floras grouped by countries, and plankton botany grouped into temperature zones).

When we attentively consider the foregoing we note that:

1. The first division is made to include much more than bibliography; in fact, one may well wonder why Philosophy is included here rather than under Evolution; why Text-books are not entered in one or more places under the 'General Works,' for which provision is made in each division; and why Lectures and Essays should not be similarly distributed according to the subjects of which they treat.

2. The use of 'Anatomy' in the sense of Histology in the third division will lead to confusion. Anatomy as generally understood refers to the gross structure, as contrasted with minute structure, with which Histology concerns itself, and since the treatment in the third division is evidently intended to be histological it will be better to use the more appropriate term—Histology.

3. In practice there will be much confusion between Taxonomy and Geographic Distribution. The latter, in spite of its name, appears not to include what we now call Phytogeography or Geophytography; on the contrary, it is rather the geographic distribution of the books and papers; thus Gray's Manual would appear under the subhead 'North America,' while Hooker's Student's Flora would appear under 'Europe,' etc. One is puzzled to know what to do with Ellis and Everhart's 'North American Pyrenomycetes' under this scheme; is it to be put under Taxonomy, or under Geographic Distribution, with other North American floras?

4. In regard to minor matters one is compelled to object to the treatment of the reproductive organs. Under 'External Morphology and Organogeny' we have the following titles, viz.: Reproductive Organs, Flower and Inflorescence, Fruit, Seed, Sporangia, Vegetative Organs of Propagation, and under 'Anatomy, Development, and Cytology' we find these heads, viz., Reproductive Organs, Flower and Inflorescence, Perianth, Andrœcium, Gynœcium, Fruit, Seed, Sporangia (Cryptogamic), Sexual Organs (Cryptogamic), Vegetative Organs of Propagation. With such a schedule what can we do with papers treating of the prothallia of Pteridophyta, the uredospores of the Uredineæ, or the bosidiospores of the mushrooms and puff-balls? The trouble here is that the schedule is either not full enough of particulars or too full in certain lines, thus emphasizing the want of particularity in others.

5. The insertion of Botanical Gardens, Museums and Herbaria in the division 'Taxonomy' is, to say the least, quite unexpected. Why we should regard these illustrative collections of plants as taxonomic is impossible to make out. These constitute and are as much a part of Morphology, Anatomy, Physiology, Pathology and Geographic Distribution as they are of Taxonomy. They should be given separate place or be introduced under each of the foregoing heads.

As we run over the schedule prepared by the International Committee we cannot help wishing that they had had access to the as-yet-unpublished address by Dr. Wm. Trelease on 'The Classification of a Botanical Library' given before the Botanical Seminar of the University of Nebraska in May, 1898, embodying the results of years of study of the problem. This is not the place in which to discuss Dr. Trelease's classification, especially since it has not yet appeared in print, but it may not be out of place to call the attention of the International Committee to it, as we understand that it is to appear within a few months.

It is evident that we must look to some one like Dr. Trelease for the solution of the problem. The librarians cannot solve it, nor can the botanists themselves; the former know too little of botany, and the latter know too little about library technique. We must look to the men who are modern, working botanists, and who at the same time have charge of large botanical libraries, as they alone are able to see the botanical needs, on the one hand, and the library limitations, on the other.

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ANTHROPOLOGY.

The International Catalogue Committee naturally encountered special difficulties in dealing with the subject of anthropology, for the reason that this youngest of the sciences is not yet organized in a manner acceptable to the entire body of students. It is doubtless for this reason (at least in considerable measure) that the scheme proposed is not classific in any proper sense, but rather a nearly random assortment of catchwords of two degrees of magnitude. Thus, while the first major division, 'Museums and Collections,' is a fairly logical and convenient one, and its subdivisions are clearly defined and acceptable, the other major and minor divisions form a curious medley. The remaining major divisions are 'Archæology,' 'Anthropometry,' 'Races,' 'Industrial Occupations and Appliances,' 'Arts of Pleasure,' 'Communication of Ideas,' 'Science (chiefly of primitive races),' 'Superstition, Religion, Customs,' 'Administration' and 'Sociology (chiefly of primitive races).' The first of these divisions is based on individual objects defined by a time limitation; the second is based on laboratory procedure and apparatus; the third has a material objective basis, but the units are collective and not all individual; the fourth and fifth divisions are based on activities and not on objects, and there is an implied time limitation growing out of the separate arrangement under 'Archæology;' while the remaining divisions are partly objective yet chiefly activital, partly individual yet chiefly collective in basis. The heterogeneity in the divisions, both primary and secondary, suggests studied avoidance of attempt to classify the Science of Man in any comprehensive way.

By reason of the diversity in basis, considerable overlapping of even the major divisions is occasioned; *e. g.*, 'Archæology' overlaps the fourth and fifth divisions in a manner peculiarly inconvenient to students who interpret prehistoric artifacts through study of the handicraft of living savages and barbarians, while 'Administration' and 'Sociology' mean so nearly the

same thing that these divisions practically overlap throughout. For the same reason, certain divisions are unduly restricted; *e. g.*, 'Customs' is used in a narrow sense, while the term is commonly extended over nearly the whole range of the human activities. Perhaps for a similar reason, there are serious lacunæ in the scheme; 'Prehistoric human remains' (a subdivision of "Archæology') and several subdivisions of 'Anthropometry' have place, yet there is no place in the scheme for the important subject of somatology; so also 'Superstition' and primitive 'Science' (whatever that may mean) receive ample space, while there is no philosophy (or mythology), which constitutes a leading subject of anthropologic inquiry. Possibly somatology and philosophy are relegated to other primary categories not included in Anthropology; but, if so, the confusion in the mind of the anthropologist desiring to use the catalogue will be only the greater. On passing to the subdivisions, both the overlapping and the lacunæ become still more conspicuous; indeed, the instances are too many for citation without practically rewriting the list.

It is only fair to ascribe much of the chaotic character of the scheme to the ill-organized state of the science; yet no extension of fairness can conceal the conspicuous fact that the scheme *is* chaotic, and to such an extent as to incommode seriously the anthropologist who may seek to apply it.

The applicability of the scheme may easily be tested by an example or two. Suppose Dr. Boas' rather special memoir on 'The Social Organization and the Secret Societies of the Kwakiutl Indians' be selected, and suppose it be catalogued by actual content: In the first place, it is based primarily on collections in the National Museum, and its illustrations are largely representations of Museum specimens indicated by Museum numbers, which would place it in the first major division of the scheme, with the subdivision number 0030. Then some of the objects and traditions described are essentially prehistoric, so that it would seem to require entry under the second major division, perhaps in number 0650; while there is sufficient reference to racial characteristics to suggest entry under the fourth division, say in number 1950. Certainly, too, the work would have to be entered in each of the next three major divisions, probably under numbers 2000, 2050, 2370, 2400, 2500, 2510, 2520, 2600, 2700, 3000, 3050, 3100, 3400, 3550, 3600 and 4100; while it would also find necessary place under each of the remaining major divisions, and in at least a dozen more numbers. All this for a single moderately special memoir! Another example, taken at random, is Dr. Carus' recent pamphlet on 'Chinese Philosophy,' a memoir of special scope and of particular significance to museum workers as well as to general anthropologists. In the absence of an appropriate general division, it would require introduction probably under 'Arts of Pleasure,' and certainly under 'Communication of Ideas,' 'Science,' and 'Superstition, Religion, Customs,' and ought to be entered under 3100, 3550, 3600, 4100, 5100, 5400, 5500, and possibly three or four other numbers. These examples suffice to illustrate the difficulties in the way of cataloguing anthropologic literature under the scheme proposed; indeed, it would be a wise anthropologist who could, without burdensome repetition, catalogue under the scheme any considerable mass of literature, even for his own use, in such manner as to give him much aid in scanning the literature a few years later; while the uncertainty of cataloguing for others, or of depending on the cataloguing of others, would seem to outweigh any advantage attending the proposed schematic arrangement. The difficulties of cataloguing would naturally be greatly diminished if the cataloguer con-

fined attention to the titles; but they would not disappear, as the examples show, while the value of the catalogue would be greatly reduced. Of course, the difficulties are due largely to the unorganized condition of the science; yet it does seem practically certain that any single anthropologist, well abreast of the science and working constructively, might have evolved a homogeneous and consistent scheme, by which anthropologic cataloguing would be facilitated rather than burdened.

Inspection of the scheme raises the question whether it is designed primarily for the use of librarians, or for the convenience of scientific workers; and the arbitrary features at once suggest that the users contemplated cannot be investigators, of whom the great majority are accustomed to methods of gaining and maintaining acquaintance with scientific literature quite unlike those embodied in the scheme. These usage-honored methods are epitomized in the systematic lists of contents and (more especially) the indexes with which respectable scientific books are provided. Now the character of current indexes of anthropologic books (particularly those prepared by authors themselves) indicates that the ideas of investigators are crystallized about certain nuclei, which are essentially denotive—names of men, names of books, names of races or nations or tribes, names of places, etc.; there is relatively slight attempt, so far as the indexes show, to crystallize ideas about necessarily vague connotive nuclei. It is true that the typical list of contents is much more largely connotive than the typical index; but even here there is a strong tendency toward arrangement in terms of trenchant concepts, *i. e.*, in denotive terms. What is true of anthropologic literature is measurably true of the literature of other branches of science, though most or all of the other branches are so well organized as to yield larger series of specific terms habitually used in denotive sense. The scientific makers and users of indexes are concerned with the essentials of scientific literature, rather than with the mere externals which appeal to the librarian *per se;* and the weakness of the scheme herein noted would seem to lie in the fact that it gives no promise of guiding or aiding the investigator in any useful way, howsoever convenient it may be as a guide to book-handlers concerned only with the external aspects of anthropologic publications.

The final test of the value of any catalogue is found in the practical operation of the law of supply and demand, with respect to both raw material and finished product. As bearing on this test, it may be observed that no working anthropologist in the Bureau of American Ethnology would seriously undertake the cataloguing of anthropologic literature, or any branch thereof, in accordance with the extravagantly complex scheme of the Royal Society Committee, and that the library of the Bureau could not be arranged under it; also that, while the office would probably subscribe for author cards and the lustral book-catalogue, the subscription for the latter would be made much more freely if it were a simple author list. And the arbitrary symbols on cards and pages would be regarded merely as trivial blemishes, unsightly but not necessarily mischievous.

W J McGEE.

THE ROYAL SOCIETY OF CANADA.

THE eighteenth annual meeting of the Royal Society of Canada was held at Ottawa from May 22d to 26th. Fellows from the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia were present. The Council met in the office of Sir John Bourinot, House of Commons on Monday, and Tuesday morning the regular work of the Sections began. The readers of SCIENCE will recall to mind that

this Canadian Society is divided into *four* sections, viz.: Section I., French poetry, literature, history, etc.; Section II., English literature, history, poetry, etc.; Section III., Mathematical, physical and chemical sciences; Section IV., Geological and biological sciences. Among the more interesting papers read before this Society, in the field of letters and science, the following are noticed: 'First Three Years in Acadia under the English Régime,' by P. Gaudet; 'Responsible Government under Lord Sydenham,' by Hon. Jos. Royal; 'Quebec in 1730,' by Abbé Gosselin; 'Literary Development in Canada,' by Hon. J. W. Longley, Attorney General of Nova Scotia; 'The Builders of Nova Scotia,' by Sir John Bourinot; 'Migration from the Canary Islands to the Eastern Coast of America,' by John Campbell, LL.D. This paper indicates the presence of extensive Celtic and Basque elements in the languages of Peru, and traces these to the Canary Islands, where history finds Celtic colonists, and recently discovered inscriptions, presented in the paper, reveal the existence of petty Iberic kingdoms alongside of them. The Celts came from the Berber area of northwestern Africa, and the Iberians from Spain. As the Toltecs and Olmecs, these Iberic and Celtic colonists from the Canaries entered Mexico in the beginning of the eighth century A.D., and when expelled, in the middle of the eleventh century, they founded the Peruvian Empire of the Incas, but tradition indicates that a portion of the Celtic crews from the Canaries landed in Florida, and that their descendants, after the time of European colonization, became known as Welsh Indians. Linguistic enquiries tend to trace the survivors of these to Arizona and California in the west, and to the almost extinct Adaizans of Louisiana in the east.

'Hochelagans and Mohawks, a Link in Iroquois History,' by W. D. Lighthall, M. A.; 'The Valley of the Ottawa, 1650–1700,' by Benjamin Sulte.

'Historic Places and Events in New Brunswick,' by Professor W. F. Ganong, Ph.D., M.A.; 'The Distinctive Characteristics of the Japanese and Chinese People,' by Professor E. Hamilton Sharp (of Tokio University).

'The Synchronism of Terrestrial Magnetic Disturbances and Unusual Excitation in the Trails of Comets,' by Arthur Harvey; 'Illustrations of Remarkable Secondary Tidal Undulations on January 1, 1899,' by W. Bell Dawson; 'Canadian Geological Nomenclature,' by Dr. R. W. Ells, President of Section IV.; Studies on Cambrian Faunas No. 3, ditto No. 4, including the 'Upper Cambrian Fauna of Mt. Stephen, British Columbia,' and 'Fragments of the Cambrian Faunas of Newfoundland,' and by the same author 'The Etcheminian Fauna of Smith's Sound, Newfoundland,' all by Dr. G. F. Matthew. The Mt. Stephen fossils are remarkable for their excellent mode of preservation. The author correlates the genera with European forms of Upper Cambrian age. New fossils from Newfoundland are described and recorded, others redescribed. The zoological position of the Hyolithidæ is discussed, and the author concludes that they should be classed with the Tubicolous Worms. Figures and descriptions will accompany these papers.

'Notes on some additions to the Molluscan Fauna of the Pacific Coast of Canada,' by Rev. G. W. Taylor, M. A., of Nanaimo, B. C. The author gives notes on *forty* species not hitherto recognized.

'Origin and History of some new varieties of Wheat produced at the Dominion Experimental Farms,' by Dr. William Saunders, Director. The most promising crossbred varieties of wheat produced during the last ten years at the Experimental Farms of Canada are discussed at length. Re-

markable success was obtained in the experiments. Particulars are also given as to how these varieties compare with the *standard* sorts in cultivation and notes on their adaptability to the different climates of Canada.

'The Scientific Work of Professor Charles F. Hartt,' by Professor G. U. Hay, M.A., Ph.B. A tribute to one of Canada's most illustrious sons who laboured successfully in the field of Geological Science, first in Canada, then in Cambridge and later in Brazil, where he fell a victim to yellow fever, in 1878, at Rio Janeiro, where he held the post of Director of the Geological Commission.

'Recent additions to the Injurious Insects of Canada,' by Dr. James Fletcher, F.L. S., etc. This paper treats of the several injurious species which have attracted public attention by their ravages upon crops of all kinds for the last twenty years. It will form a most practical as well as scientific treatise on a subject of vital importance to Canada.

'Catalogue of Canadian Proctotrypidæ,' by W. Hague Harrington, Esq. Two hundred species are enumerated, most of which come from Ottawa and its vicinity. Descriptions of new species are given and notes on the habits of several species added.

'On the Origin of the Silvery Appearance in the Integument of Fishes,' by Professor E. E. Prince, B.A., F.L.S., and 'Some Chitinous Elements in the Larval Skeleton of Fishes which appear to be Primitive,' by Professor E. E. Prince, also form two interesting contributions to the science of biology.

'The Geology of the more important Cities in Eastern Canada' is the title of a paper by Dr. H. M. Ami. Geological tables have been drawn up for St. John (New Brunswick), Quebec City, Montreal, Ottawa, Kingston, Toronto, Hamilton and London.

Professor T. Wesley Mills, of McGill University, entertained Section IV. with an intensely fascinating subject, 'An Investigation of the Physiology of the Brain of the Bird,' together with 'An Examination of some points in the Psychology of that Animal.' Two pigeons whose brains had been almost entirely removed and wounds healed have been subjected to close examination and their behavior noted. Upwards of four months have elapsed since the operation was performed, and Dr. Mills awaits further developments before submitting the healed parts to a microscopical examination.

On the evening of the 23d of May—an evening with our Canadian poets and writers was held with immense success. Dr. W. H. Drummond, of Montreal; Wilfred W. Campbell, of Ottawa; W. A. Frazer, of Toronto; W. J. Phillip-Woolley, of British Columbia; Attorney-General Longley, of Halifax, Nova Scotia; Duncan C. Scott, of Ottawa; Dr. Louis Frèchette, Laureate of the *Académie de France*, of Montreal, and Revs. Frederick G. Scott, of Drummondville, Quebec, and Archbishop O'Brien, of Halifax, took part.

At the public meeting Professor Rutherford, assisted by Professor John Cox, of the Physics Laboratories, McGill University, described and illustrated 'Wireless Telegraphy' to a large audience with marked success.

H. M. Ami.

Ottawa, June, 1899.

SCIENTIFIC BOOKS.

The Anatomy of the Central Nervous System of Man and of Vertebrates in General. By Professor Ludwig Edinger, M. D. Translated from the Fifth German Edition by Winfield S. Hall, Ph.D., M. D., assisted by P. L. Holland, M.D., and E. P. Carlton, B.S. The F. A. Davis Co. Pp. 446. Figs. 258.

Few books could be more welcome in an acceptable English dress than the last edition of Edinger's 'Vorlesungen ueber den Bau der Ner-

vösen Centralorgane,' the greatly enlarged fifth edition of which has been for some time in our hands and has quite superseded the translation by Dr. Riggs, though the latter has already served a useful purpose in introducing our author to the American public. The transformation which this book, intended simply to give a summary of the best-established facts of neurology for busy people, has undergone in so short a time is a good index of the progress the science has been making.

Professor Edinger quotes with approbation the suggestion of Burdach that, in addition to the gathering of building material, every period brings with it the obligation to attempt anew the rearing of a structure presenting the knowledge in definite form. This synthesis of our present knowledge Edinger endeavors to give. In some parts of the edifice, it is true, the efforts result chiefly in making more evident great gaps to be filled. This is for the active investigator a most important service in itself, especially when brought into relation with the received facts in such a way as to afford a perspective of the path which research may profitably follow.

No one now-a-days could fail to appreciate that the light needed for the decipherment of the intricate structure of the human brain must come from the study of the simpler brains of lower vertebrates, and no one has had better opportunities than Professor Edinger to supply just this light. Not only have his own studies peculiarly fitted him for this work, which his experience as practical physician and teacher has tended to keep in touch with human interest, but the duty of preparing a yearly summary for Schmidt's *Jährbucher* has enforced the necessity of a minute knowledge of the work done in these lines by others the world over. More than any other leading European neurologist he has familiarized himself with the work of his contemporaries in all lands.

The book as it now stands contains, in addition to the material of the original twelve lectures on the structure of the mammalian brain which now constitutes Part III., an introduction devoted to fundamental conceptions and physiology of brain and peripheral nerves, and Part II., a review of the embryology and comparative anatomy of the vertebrate brain. It may be admitted that this method of treatment is at the expense of unity and entails some repetition, yet the practical advantage to the student who may be chiefly interested in human anatomy is manifest.

The results of the author's studies of the fore-brain and mid-brain of reptiles are here used to great advantage. It has been a matter of surprise to the present reviewer that the desirability of starting with the reptilian brain has not been more clearly recognized by teachers of the comparative anatomy of the brain, for in this group we have a degree of simplicity without the puzzling interference of the specialized structures found in the brain of fishes or the embryonic lack of differentiation seen in amphibia. The present book makes this course possible and presents the strongest possible reasons for pursuing it.

As might have been expected, the olfactory apparatus is clearly and fully treated, as are the cephalic parts of the brain in general.

The discussion of the cerebellum, on the other hand, is somewhat less satisfactory than the other sections, and serves very vividly to enforce the need of thorough comparative work on this organ in spite of the wealth of isolated facts recently accumulated. "Of the connections and definite course of the fibers of the cerebellum there is, as yet, little known." "Where the inferior cerebellar peduncle enters the cerebellum is the least understood portion of the whole nervous system." "Least known as to their real origin are several frontal tracts." "The relation of the nuclei to the fiber system of the white substance is almost wholly unknown." In fact, it has to be admitted that we have but the vaguest idea of the relations of the afferent, efferent and special sensory fibers that have been traced into or to the cerebellum. The present writer may remark that his suggestion, made several years ago on the basis of a study of types from nearly all groups of vertebrates, that connections are established, by way of certain 'switch cells' in the pes pedunculi, between descending motor tracts from the cerebrum and fibers to the cerebellum, has remained unchallenged, and offers a reasonable basis for interpreting some of the facts of phys-

iology. It is not correct to say with our author that the cerebellum is ontogenetically developed from a simple cell plate. There is abundant evidence that the cerebellum is essentially a paired organ, and this, too, is in harmony with its function. The curious method of supplying its surface where the bulk is increased, as in mammals, by lateral diverticles deserves passing mention.

The English translation is neatly printed, though there are a few mistakes which greater care would have avoided. Figure 3, for example, is wrong side up, and thus the description is belied.

The translation is far from faultless, though for the most part intelligible. We are prepared to find that a translator should be so influenced by the idiom of the original as to produce a somewhat halting English style, and it often happens that the translator's own style leaves something to be desired, but there is no excuse for translating Gehörgrube as oral pit, as Dr. Hall has done. Fasersystem appears as 'tract' in a connection where it is important to distinguish between these terms. 'Dicht anlegen' is translated 'lie close beside.'

On page 16 the author is made to say 'all vertebrates,' where the original says 'all lower vertebrates,' and proceeds to make an important distinction between lower and higher vertebrates.

We do not wish to enter upon the field of vexed neuronomy, but regret that the translator was not satisfied with 'neurite' or 'axis cyclinder,' as used by the author, and substitutes the less satisfactory 'neuraxon,' which Dr. Edinger did not use at all. 'Fundament' for 'Anlage' is to us an unpleasant word, to say nothing of its ambiguous sound. 'Proton' is sufficiently well known. It seems strange that in an English work we should need to puzzle over the terms of direction 'up and down,' 'back and forward,' etc. Minor inaccuracies like 'mantel' for 'mantle' in one place are probably slips in proof-reading.

On the whole, then, while we congratulate ourselves on this addition to the resources of the teacher of neurology, we hope that a later edition may remove these causes for irritation to the instructed reader. C. L. HERRICK.

The Characters of Crystals, an Introduction to Physical Crystallography. By ALFRED J. MOSES, E.M., PH.D., Professor of Mineralogy, Columbia University, New York City. New York, D. Van Nostrand Company. 1899. Pp. 211.

This little volume contains the principles of modern crystallography and descriptions of the instruments and methods used in the determination of the various physical characters of crystals. The advanced student in mineralogy and crystallography will find it of much assistance, because it presents in a concise form, omitting unnecessary detail, the subjects treated of in the larger foreign text-books on physical crystallography.

The contents are divided into three parts, the first dealing with the geometrical characters of crystals. In the classification of the thirty-two types of crystals the author has followed Professor Groth, and has wisely retained the same descriptive names for the classes and forms. The common methods of measuring crystals are well described, but a more complete description of the use of the two-circle goniometer would have been better, since this instrument will undoubtedly be used in the future by the advanced worker more than the ordinary goniometer; also in the chapter on crystal projection no mention is made of the gnomonic projection, the value of which Professor Goldschmidt has so well demonstrated. This projection possesses so many advantages over Miller's that it, in connection with the use of the two-circle goniometer, should be understood by every mineralogist.

An excellent course in optical crystallography is given in the second part of the book. The causes of the various optical phenomena and the latest methods for the determination of the optical characters of crystals are explained briefly, yet clearly enough for the student to readily understand this difficult subject.

The third part treats of the general physical characters, such as the effects of heat, magnetism, electricity, etc., on crystals. The author appends a synopsis of an advanced course of crystallography as given at Columbia University. The book is well illustrated by crystal-drawings and by cuts of instruments, and fre-

quent references to original articles are cited in the foot-margins.

This is the first American text-book on purely physical crystallography, and, containing, as it does, the sum of what is at present known on the subject, it must commend itself to every student of the science.

A. S. EAKLE.

HARVARD UNIVERSITY.

Algebra for Schools. By GEORGE W. EVANS, Instructor in Mathematics in the English High School, Boston, Mass. New York, Henry Holt & Co. 1899.

This book is a fresh treatment of the topics commonly found in algebras for schools. It is by no means a mere compilation or reprint with slight alteration of texts now before the public. While, of course, it is not, nor pretends to be a contribution to knowledge, it is distinctly what the author has sought to make it, a real contribution to the art of presenting knowledge to the beginner. Ordinary algebra is, in its elements at least, nothing but an extension and refinement of common sense applied to number. Consistently with this idea, the author's arrangement of topics, as well as his method of attack —in both of which respects there is a noticeable departure from tradition—are well adapted 'to preserve the pupil from the besetting sin of conceiving algebraic operations as a species of legerdemain.' An appeal is invariably made, in the first instance, to the reader's practical sense. Theory is not slighted; being approached through concrete examples, it is, however, rather produced than presented, and its correctness is not so much demonstrated as its *reasonableness* is shown. As instances of this procedure may be cited the treatment of signs, imaginaries and exponents. In case of the latter two themes the spirit is particularly commendable. Among other specially praiseworthy features are the chapter on the abbreviation of rules by means of symbols; the prominence given to identities, together with the clear distinction between the latter and equations of condition; the geometric interpretation of the simplest equations; the extended and accentuated treatment of factoring and of the quadratic equation; the discussion of the notions of constant, variable and limit, and the abundance and variety of exercises not copied from other works. An easily detectable slip in logic occurs on p. 105 in justifying steps (4) and (6) by reference to axiom A. The proper justification is that such equations are satisfied if either factor be equated to zero.

An adequate characterization of the book is impossible in so short an account. That it is immensely superior to the average of its rivals is obvious on comparison. It should be added that the book is written in excellent English, and is well printed and well bound.

C. J. KEYSER.

COLUMBIA UNIVERSITY.

The Emotion of Joy. By GEORGE VAN NESS DEARBORN, A.M., M.D. New York, The Macmillan Company.

This monograph opens with a rather extended vindication of parallelism, but the writer cannot keep to this point of view, *e. g.* pages 8, 13, 14, 16. But at any rate parallelism at present is metaphysical, exact coincidence of external expression and internal emotion is yet to be shown experimentally, and, as assumption, it is obscurrantist in breaking up the universal causal nexus, which is the basis of science, and putting a bare dualism for rational coordination. Of course the difficulty of experiment seems insurmountable, since the agent can only indicate to us the moment of his emotion by an expression. After outlining the general parallelistic doctrine of emotion, Mr. Dearborn presents some experiments which are so hypothetical as to be only of the slightest value in revealing the opinions of fourteen persons as to how they would feel and act if given sums of money from ten to ten thousand dollars. Much the most interesting and valuable part of this paper is that which reports researches on the effects which pleasantness and unpleasantness have upon the involuntary muscular movements. It is particularly interesting to notice that "the left hand appears much more sensitive to involuntary reaction than the right, and this was to be expected, perhaps, most of the subjects being right-handed and, therefore, with their right hand 'civilized,' so to say, away from the original biological habits of emotional con-

comitance." Of course this is a wider field than mere joy as specific emotion, but inclusive of it. It may be surmised that the expansive movement for the pleasant and contrary for painful stimulus—which is reinforced by these experiments—is simplest biological reaction concerned with appropriation and rejection in feeding by primitive organisms. However, joy as specific emotion is later and must be studied more introspectively in its functional activity than Mr. Dearborn has done. In neurasthenia joy does not act, as I recall in my own case, once receiving news which normally would have brought great joy but left me quite listless at the time.

HIRAM M. STANLEY.

BOOKS RECEIVED.

The Races of Europe, a Sociological Study. WILLIAM Z. RIPLEY. New York, D. Appleton & Company. 1899. Pp. xxxii+624.

A Selected Bibliography of the Anthropology and Ethnology of Europe. WILLIAM Z. RIPLEY. New York, D. Appleton & Company. 1899. Pp. 160.

Plant Relations. JOHN M. COULTER. New York, D. Appleton & Company. 1899. Pp. 264.

Industrie des matières colorantes azoïques. GEORGE F. JAUBERT. 1899. Pp. 167.

Transactions of the American Microscopical Society. Edited by the Secretary. Lincoln, Neb., Hunter Printing Co. 1899. Vol. XX. Pp. 369.

Report of the Meteorological Service of Canada for the year ending Dec. 31, 1896. R. F. STUPART, Director. Vol. I., pp. 295; Vol. II., pp. 796.

The Soluble Ferments and Fermentation. J. REYNOLDS GREEN. Cambridge, University Press. 1899. Pp. xiii+480. 12s.

SCIENTIFIC JOURNALS AND ARTICLES.

THE June number of the *Bulletin of the American Mathematical Society* contains a report of the April meeting of the Society, by the Secretary; 'Surfaces of Revolution in the Theory of Lamé's Products,' by Dr. F. H. Safford; a review of 'Picard's Algebraic Functions of Two Variables,' by Arthur Berry, M.A.; 'Note on Page's Ordinary Differential Equations,' by Dr. L. E. Dickson; a review of 'Tannery's Arithmetic, by Professor James Pierpont; 'Notes,' and 'New Publications.' The July number of the *Bulletin*, which concludes volume 5 of the new series, contains 'The Asymptotic Lines of the Kummer Surface,' by Dr. J. I. Hutchinson; 'On a Definitive Property of the Covariant,' by Mr. C. J. Keyser; 'The Known Finite Simple Groups,' by Professor L. E. Dickson; a review of 'Schoenflies's Geometry of Movement' and of its French translation by Speckel, by Professor F. Morley; a review of the new edition of 'Weber's Algebra,' by Professor James Pierpont; 'Shorter Notices;' 'On Elliptic Functions,' by Professor James Pierpont; 'Notes;' 'New Publications;' annual list of papers read before the Society and subsequently published, and an elaborate index of the volume.

THE June number of the *Botanical Gazette* opens with a morphological study of the common May apple, *Podophyllum peltatum*, by Mr. Theo. Holm, illustrated by ten figures drawn from nature by the author. Mr. Holm discusses the mode of germination, the distribution, relation and arrangement of the leaves and buds. Some structural details of the mature plant are also given. The study shows clearly that *Podophyllum* is closely related in its habits and ecological peculiarities to a little natural group of plants: Diphylleia, Jeffersonia, Caulophyllum, Actæa and Cimicifuga. He thinks it better to associate these plants than to separate them by the insignificant floral characters which have been used to put them into separate orders. Capt. John Donnell Smith continues his description of new plants from Guatemala and other Central American republics. Mr. T. S. Brandegee also describes a considerable number of new species of Western plants. Dr. C. O. Townsend discusses the effect of ether upon the germination of seeds and spores. He finds that a weak atmosphere of ether tends to hasten the time of germination, while a larger amount of ether retards or prevents it. Dr. A. P. Anderson figures and describes a new Tilletia parasitic upon the cultivated rice. An appreciative biographical sketch of the late Dr. Alvin Wentworth Chapman is contributed by Dr. Charles Mohr, a long-time friend of Chapman. It is accompanied by a small but excellent portrait of Dr. Chapman. Professor F. A. Waugh discusses the application of the name *Prunus insi-*

titia, concluding that Linnæus meant by it *Prunus domestica Damascena*, while Gray applied it to *Prunus spinosa*, and Walter to *Prunus angustifolia*. Walter H. Evans describes a new branch from Alaska. A fascicle of Book Reviews, Notes for Students, and News complete the number, which is the concluding one of Volume XXVII.

AT the annual meeting of the American Medical Association Dr. George M. Gould, of Philadelphia, proposed that the publication of the *Index Medicus* should be undertaken by the Association. He moved the following resolution, which was referred to the Board of Trustees:

WHEREAS, the suspension of the publication of the *Index Medicus* is a deplorable event, which will result in greatly increased labor on the part of medical men in their literary work, and seriously hindering the progress of medical science, practical as well as literary.

Be it therefore Resolved, That the Executive Committee of the American Medical Association appoint a committee of three members of the Association to take charge of the publication of the periodical, perfect plans for the same and engage the service of an editor and of such editorial assistance as may be required; also to choose a publisher and to make contracts with him for the printing, distribution, etc., of the work all in such manner as to continue the high standards of accuracy and bibliographic usefulness so well established by the previous publishers.

Resolved, That the Treasurer be instructed to pay all bills of such Committee in payment of necessary expenses of such editing and publication, providing that this outlay does not exceed annually $3,000.

DR. H. C. MULLER, of Utrecht, Holland, is preparing to publish an *International Journal of Linguistics*, which is to follow the lines of the *International Zeitscrift für Sprachwissenschaft*, which was discontinued after the death of its editor, Dr. Techmer, of Leipzig.

DISCUSSION AND CORRESPONDENCE.

THE U. S. NAVAL OBSERVATORY.

I HAVE been very much interested in the discussions which have appeared in SCIENCE regarding the Naval Observatory, but, so far as I can learn, certain points have been overlooked which ought to be brought out very plainly.

In the first place, it was really intended by those members of Congress who were influential in having the institution established that it should be devoted chiefly to scientific work. The label of 'Depôt of Charts and Instruments' was added to it, and the plea of utility was employed, because it was feared that the public would not support a scientific institution. For this reason, also, the institution was placed under the Navy Department, since the salaries of the professors and officers engaged in astronomical work would come from the pay of the Navy and would not appear under the Observatory appropriations.

Though a number of eminent men have been in charge of the Naval Observatory, the chief criticism to be made regarding it would seem to me to be the lack of a continuous, well-defined policy. Our Navy has been built up at times and then been allowed to run down, and the line officers have had but little to do. At such times they want control of everything connected with the service, and the scientific work of the Observatory has had to go to the wall. This was the case for some years before the War of the Rebellion, and also about 1882. Of course, a number of the line officers who have been at the Observatory have been able men, who, with time enough given them, could learn anything or do anything. The reason why they did not do well in astronomical work usually was that it took them too far from the profession for which they had been trained.

Logically, I think the Naval Observatory should be placed under scientific management and taken from the Navy, but, as affairs are really managed under our government, with a chance for the methods of the practical politician, I am not so sure. Several years ago an attempt was made to change the organization of the Observatory, and the Naval Committee of the House of Representatives gave a hearing to those interested in the matter. Judging from that hearing, several questions of this kind will have to be answered in the present discussion.

If the work of the Naval Observatory is compared with that of other large observatories in this country, both as to quality and cost, has not the naval management been as good as any other in this country?

Is the present movement being pushed for the benefit of any particular person? This question was asked at the hearing referred to by the Chairman of the Committee.

Are there not already too many detached organizations scattered throughout the departments of the government in such a manner that their business affairs cannot be properly supervised?

This objection might be met by saying that all the scientific work of the government should be brought together under one department, under proper supervision, and with committees in Congress to look after it. Indeed, it seems to me likely that Congress would pass some general measure of this kind rather than take up special legislation for the Observatory alone.

A. Hall, Jr.

Ann Arbor, June 30, 1899.

CEREBRAL LIGHT AGAIN.

In 1897 Dr. Scripture contributed a note to Science (Sci. 6, p. 138, July 23) on what he calls 'cerebral light.' Soon afterward (Sci. 6, p. 257, Aug. 13) I tried to show that whether the phenomena described was of cerebral origin or not the observations of Dr. Scripture did not prove it. I fear Dr. Scripture did not see my criticism.

Now, again, Dr. Scripture brings forward (Sci. 9, p. 850, June 16, 1899) what he thinks demonstrative proof of cerebral origin. Observing the cerebral figures in the early dawn, and looking at the window, he was able to see the figure in the frame of the window. "Now," says he, "placing the fingers of the two hands against the outer ends of the two eyeballs, I displaced them simultaneously in opposite directions. As a result there appeared two images of the frame moving in opposite directions. But the retinal figures seen in front of the frame remained single and *did not move.* Granting that there was no error in my observations, I cannot imagine a more conclusive proof as to the cerebral nature of the light."

Now, I freely grant that there was no error in his observation, yet his conclusion does not follow. In proof of this it is only necessary to make the same experiment with any after-image, say that of the sun. I have just done so. *It behaves in exactly the same way as his cerebral figures.* The reason is obvious. When we press on the sides of the eyeballs external images of *objects* move in the field of view because their retinal images move on the retina. But retinal brands do not move on the retina and, therefore, their spatial representatives do not move in the field of view. I pointed this out in my previous criticism, and this is the reason I think that Professor Scripture did not see it.

As to whether the phenomenon described, or, indeed, any after-image, is retinal or cerebral I have nothing to say. Whether a change in a cerebral cell has its origin in a peripheral impression (retinal), or in the course of an optic fiber, or in the cell itself, it may be difficult to say.

Joseph Le Conte.

Berkeley, Cal., June 28, 1899.

POT-HOLE VS. REMOLINO.

To the Editor of Science: The term 'pot-hole,' so frequently applied, of late, to rounded cavities formed by rivers in their rock-beds, is inelegant and grates harshly on people of sensitive temperament. I suggest, in place of it, the Spanish word *remolino*, which is the common designation in the Republic of Colombia, for phenomena of this order.

Oscar H. Hershey.

Freeport, Ill., June 19, 1899.

ASTRONOMICAL NOTES.

PROPER MOTION.

A valuable contribution to the list of stars with proper motions is made by Professor Porter, Director of the Cincinnati Observatory, in Publication No. 14 of that Observatory. This is in continuation of similar studies previously published, and contains the results of meridian-circle observations of 2,030 stars made between 1893 and 1898, and a careful comparison with earlier observations. A large number of the stars have an appreciable proper motion.

FUNDAMENTAL STAR CATALOGUE.

There has recently been distributed Vol. VIII., Part II., of the publications of the Nautical Almanac Office, which contains Professor

Newcomb's catalogue of 1,596 stars reduced to an absolute system by the methods explained to the Paris Conference in 1896. The Conference authorized the preparation of the catalogue as a provisional fundamental catalogue, and the British and French Almanac Offices assisted in the calculations. The star places are given for 1875 and 1900. The revised catalogue of 383 stars included in the American Ephemeris for 1900 is taken from this fundamental catalogue.

PARALLAX OF THE ANDROMEDA NEBULA.

BULLETIN No. 6 of the Yerkes Observatory records an attempt by Professor Barnard to obtain an appreciable parallax of this nebula from micrometric measurements with the 40-inch refractor. Two small stars were employed and a series was obtained in July and August, 1898, followed by a second series in November and December, 1898. The differences between the two series are no greater than would be expected in such measures, and are contrary in sign to what would be required if the nebula is nearer than the stars.

A HYPERBOLIC COMET ORBIT.

THE number of hyperbolic comet orbits is so small, and their character, generally regarded, as so uncertain, that a genuine addition to the list is heartily welcomed. Mr. Aitken, of the Lick Observatory, has published in the *Astronomische Nachrichten* a definitive determination of the orbit of Comet 1896 III, discovered by Swift. A large number of observations were made at many observatories, which are discussed with great care and impartiality. The weak point in the investigation is that the observations extend over a period of but two months and four days, but the normal places are represented in a highly satisfactory manner by the hyperbolic elements. The residuals are very small in both right ascension and declination and cannot be reduced by any variation in the computed eccentricity.

WINSLOW UPTON.

PROVIDENCE, R. I., July 7, 1899.

RECENT PROGRESS IN THE EXAMINATION OF FOODS AND DRUGS.

IN the modern investigations of foods and drugs it is beginning to be recognized, to some extent at least, that it is the results of the labors of the scientific botanist and chemist which are being utilized, not only by the analyst, but also by the manufacturers of foods and drugs. New medicinal plants are being added from time to time to the materia medica; new food-producing plants are being discovered; the various active and otherwise valuable constituents of foods and drugs are being isolated and investigations made upon them; in short, the plants and their manufactured products are being so extensively investigated that it is quite possible in many cases to distinguish the pure from the spurious, and it would appear that the time is at hand for the framing of national food and drug laws. In the following an attempt is made to indicate some of the recent developments in the examination of foods and drugs.

MEDICINAL PLANTS.

AMONG the new economical plants from East Africa * may be mentioned *Mascarenhasia elastica* K. Schum. (N. O. Apocynaceæ), a tree which yields caoutchouc; *Canarium Liebertianum* Engl. (N. O. Burseraceæ), the bark of which yields a resin that much resembles olibanum; *Erythrophleum guineense* Don. (N. O. Leguminosæ), the bark of which contains Erythroplœin; and *Cordyla africana* Lour. (N. O. Leguminosæ), which yields an edible fruit.

R. T. Baker describes † two new species of *Eucalyptus*: (1) *E. dextropinea*, the volatile oil (0.85 %) of which consists largely of dextro-rotatory pinene, eucalyptol being absent: (2) *E. lævopinea*, the volatile oil (0.85 %) being made up largely of lævo-rotary pinene, but containing neither eudesmol nor eucalyptol.

The Strychnos species of Africa have been examined by E. Gilg, ‡ who divides them into two groups: (1) those with edible fruits: *Strychnos unguacha* A. Rich. (*S. innosa* Del.), *S. Quagua* Gilg, *S. cerasifera* Gilg, *S. Tonga* Gilg, also two species related to the latter whose fruits are no doubt eaten, *S. Welwitschii* Gilg and *S. cocculoides* Baker. (2) Those with poisonous fruits: *S. Icaja* Baill., *S. Kipapa* Gilg, *S. pungens* Solered., possibly also *S. spinosa* Lam. and

*Notizbl. d. Berl. Bot. Gart., 1899.

†Proc. Linn. Soc. N. S. W., 1898.

‡ Notizlb.. d. Berl. Gart., 1899, No. 177.

S. Dekindtiana Gilg. These species do not contain, according to Thoms, any of the alkaloids found in nux vomica, but contain a bitter principle, not alkaloidal in character. From specimens* collected by Mr. and Mrs. Phillips it appears that the plant recognized by the Somalis as being the source of myrrh is that figured in Bentley and Trimen's 'Medicinal Plants.'

David Hooper† records the fact that when *Psychotria Ipecacuanha* is grown in phosphatic manure in India it produces double the amount of root (by weight) than grown in ordinary soil.

Unganda Aloes‡ corresponds, according to W. A. H. Naylor and J.J . Bryant, approximately to the characters and tests of Cape Aloes.

It has been ascertained by J. Moir§ that when *Scabiosa succisa* L. (N. O. Dipsaceæ) is chewed by cattle it causes violent inflammation of the mouth and tongue.

A. Davidson|| records the fact that *Solanum Xanti* A Gray, a plant of California, and the leaves of the common cultivated fig produce eruptions on delicate skins when brought in contact therewith. The seeds¶ of an Euphorbiaceous tree, *Omphalea megacarpa* contain an oil which is mild and tasteless and which acts as a purgative producing its action in about 3 hours.

MEDICINAL PRINCIPLES.

A NEW alkaloid† has been discovered in stavesacre (*Delphinium Staphisagria*) by F. B. Ahrens, which he calls *Stapisagroin*. It does not give any of the reactions for the alkaloids here-to-fore found in *Delphinium*.

E. Kauder** finds in *Anhalonium Lewinii*, besides mescalin, anhalonidin and lophophorin two other bases, viz: *Pellotin* and *Anhalomin*.

The *Kampferid*†† previously isolated by E. Jahns from the alcholic extract of galangal root has been further studied by Ciamician and Silber. They describe it as occurring in shining yellow crystals (M. P. 227–229° C.), which are odorless and tasteless.

* Pharm. Jour. (London), 1899, p. 295.

† Ibid., p. 384.

‡ Ibid., p. 296.

§ Vet. Rec., 1899, p. 524.

|| Therap. Gaz. 1899, p. 86.

¶ Ber. d. D. Chem. Ges., 1899, p. 1581.

** Arch. d. Pharm., 1899, p. 3.

†† Chem. Centralbl., 1899. p. 1041.

The coloring principle (*Scoparin*) of *Spartium Scoparium* L. has been examined by Perkin.* He believes it to be probably methoxy-vitexin and finds that when digested with hydriodic acid it yields, besides methyl-iodide, a new coloring principle (*Scoparein*) which differs from Scoparin in possessing marked tinctorial properties.

The dried flowers of *Datura alba* from China have been examined by O. Hesse† and he finds them to contain 0.51% of hyoscine ($C_{17}H_{21}NO_4$), 0.03% of hyoscyamine and 0.01% of atropine. The hyoscyamine, while similar to that in *Hyoscyamus*, is not identical with the *Scopolamine* of Schmidt.

The active principle‡ in the root of *Calliandra grandiflora* Benth., a leguminous shrub of Brazil and Mexico, appears to be, according to the researches of Duyk, a saponin, which he has called *caliandrin*. Internally it acts as an irritant and emetic. The poisonous principle (*temulin*) contained in the seeds of Darnel (*Lolium temulentum*) is ascribed by P. Guerin§ to the presence of a fungus. The mycelia of this fungus were also present in two other poisonous species of *Lolium*.

Further investigations, by J. D. Fillipo, || upon the alkaloid in the bark of *Tetranthera citrata* show that it has probably the constitution $C_{16}H_{11}(OCH_3)_3(OH)_2.NH_1$ and that its action is similar to, but less toxic than, strychnine.

A crystalline principle has been obtained from the fruits of *Capsicum annuum* by Micko¶ which he considers to be the active principle of *Capsicum*. The crystals are white; M. P. 6—3 63.5°C.; formula $C_{18}H_{28}NO_3$. According to H. Molisch,** in the transformation of indican into indigo-blue in Indibopera, oxygen appears indispensable, and a number of bacteria and fungi accompany the reaction.

HENRY KRAEMER.

* Proc. Chem. Soc. 1899, p. 123.

† Südd. Apoth. Zeit., 1899, p. 2.

‡ Bull. Comm., 27, 81; through Pharm. Jour., 1899, p. 335.

§ Morot's Jour. de Bot., 1898, p. 230; through Ibid., p. 251.

|| Arch. d. Pharm., 1899, p. 601.

¶ Zeitschr. f. Nahr. u. Genuss., 1898, No. 5.

** Sitz. k. Akad. Wiss. Wien.; through Pharm. Jour., 1899, p. 251.

THE DECENNIAL OF CLARK UNIVERSITY.

CLARK University has celebrated its decennial in a manner worthy of a university devoted to the advancement of science. The lectures, of which we may be able to publish abstracts later, were as follows: Professor Ludwig Boltzmann, of the University of Vienna, on the 'Principles and Fundamental Equations of Mechanics'; Professor Picard, of the University of Paris, on 'Differential Equations' and on 'Analytical Functions'; Professor Angelo Mosso, of the University of Turin, on 'The Relation between Muscular Exercise and the Development of Mental Power' and on 'Bodily Disturbances accompanying the Emotions;' Professor Santiago Ramon y Cajal, of the University of Madrid, on the 'Structure of the Visual Cortex of the Human Brain,' and Professor August Forel, of Zürich, on 'Hypnotism' and on 'Arts.'

There was a large number of American men of science in attendance at the lectures. The mathematicians and physicists included Professors A. A. Michelson, E. W. Morley, E. H. Hall, Maxime Bôcher, E. B. Fine, W. F. Magie, M. I. Pupin and Mr. C. S. Pierce. Among physiologists, psychologists and neurologists present were Professors H. P. Bowditch, C. S. Minot, William James, Josiah Royce, Hugo Münsterberg, J. Mark Baldwin, J. McKeen Cattell, W. L. Bryan, M. W. Calkins, A. H. Daniels, W. O. Atwater, Wm. A. Locy and Drs. G. H. Parker and Ira Van Gieson.

PROFESSOR BEECHER'S GIFT TO YALE UNIVERSITY.

THE President of Yale University announces in his annual report an exceedingly valuable gift to the University, received on the 19th of June, from Professor Beecher, a description of which is contained in the following letter addressed by him to the Corporation:

To the Corporation of Yale University:

In grateful recognition of the honors and favors conferred upon me during my connection with the University, I herewith beg to offer unconditionally, as a gift to the Peabody Museum, my entire scientific collections.

These collections were made previous to my coming to New Haven, and represent the results of twenty years' labor. They were collected wholly by me in the field and at my own expense, and comprise upwards of one hundred thousand specimens, mostly of invertebrate fossils.

The collections represent:

1. The fauna of the Upper Devonian and Lower Carboniferous in Pennsylvania.

2. The fauna of the Middle Devonian of western New York.

3. The fauna of the Lower Devonian of central and eastern New York.

4. A small series from other geological horizons.

5. About five hundred type specimens, which have been illustrated and described in the volumes of the Paleontology of New York, in the Geological Survey of Pennsylvania and in various scientific periodicals.

The ground covered by these collections is now almost wholly unrepresented in the Museum, and the number of types of fossil invertebrates is far greater than at present belonging to the Museum. There are hundreds of specimens unique for their perfect condition of preservation and for their careful preparation to show delicate structural details. No other single collection in America is so rich in series showing the life histories of species from the embryonic to the adult state.

I have the honor to be

Very respectfully yours,

CHARLES EMERSON BEECHER.

PROPOSED INSCRIPTIONS FOR THE STATUE OF DARWIN.

THE London *Academy* has asked for an inscription of not more than forty words suitable to be engraved on the statue of Charles Darwin recently erected. Of those received they regard the following, composed by Mr. Edwin Cardross, 22 Seymour street, Portman square, W., as the best:

"Charles Darwin, the great naturalist, memorable for his demonstration of the law of evolution in organic life, achieved by scientific imagination, untiring observation, comparison and research; also for a blameless life, characterized by the modesty, 'the angelic patience of genius.'"

Other proposed inscriptions were:

"In memory of Charles Darwin, theorist, philosopher, psychologist. A student of Nature, he searched for the truth, endeavoring to understand the beginning of all things, thus to make clearer the mysteries of Nature, the revelation of which was his ambition."

[G. W., Hull.]

"To the memory of Charles Darwin, whose extraordinary abilities and indefatigable energies, ordered

by steadfast honesty of purpose and inherent modesty, combined to make him the greatest scientist of the age, the first exponent of the theory of human evolution." [J. D. Q., Shrewsbury.]

"Charles Darwin, whose patient and acute observation compelled Nature to reveal her great secret, the origin of species.

'He never turned one inch out of his course to gain fame.'" [W. E. T., Caterham.]

"Charles Darwin, on patient experiment and observation, founded a theory of evolution, which, in explaining the successive appearance of more complex forms of life in the world's history, has furnished a basis and example for all modern scientific investigation." [J. D. A., Ealing.]

The men of letters who have, it may be assumed, written the above do not appear to appreciate very fully Darwin's work. Can any of the readers of SCIENCE suggest a better inscription?

SCIENTIFIC NOTES AND NEWS.

PRESIDENT SCHURMAN, of the Commission to the Philippines, is returning to America, in accordance with his original plans, and will arrive in August. Professor Worcester will for the present remain at Manila.

DR. G. AGAMENNONE has been appointed Director of the Geodynamic Observatory of Rocca di Papa, near Rome, as successor to the late Professor M. S. de Rossi.

THE various field-parties in connection with the Geological Survey of Canada comprise the following staff, viz.: Mr. R. G. McConnell, Yukon Territory, Gold Mining District; Mr. R. W. Brock, Rossland Mining District and West Kootenay; Mr. J. McEvoy, East Kootenay Mining District; Ontario Gold Fields, Mr. Wm. McInnes; Ottawa Valley Mining District, Dr. R. W. Ells; Manitoba, Mr. D. B. Dowling; Great Slave Lake, Dr. Robert Bell; Nova Scotia Coal Mining Districts, Mr. Hugh Fletcher; Gold Mining Districts of Nova Scotia, Mr. E. R. Faribault.

HENRY B. KÜMMEL, PH.D., who has been assistant professor of physiography at Lewis Institute, Chicago, since the foundation of the Institute, has recently been appointed Assistant State Geologist of New Jersey. Dr. Kümmel has been an Assistant on the Survey for several years, and for the last four years has devoted his attention to a study of the Triassic of New Jersey, on which he has already published several papers.

AT a special meeting of the court of Victoria University at Owens College, Manchester, on June 22d, the honorary degree of Doctor of Science was conferred on Dr. J. Clifford Allbutt, F. R. S., Regius professor of medicine at Cambridge University, and on Dr. H. E. Schunck, F. R. S., the author of numerous papers on the chemistry of organic coloring matter.

SIR WILLIAM TURNER THISELTON-DYER has been elected to an honorary studentship at at Christ Church College, Oxford.

THE University of Dublin has conferred the degree of Doctor of Science on Professor A.R. Forsyth, Sadlerian professor of pure mathematics in Cambridge University.

MR. JOHN R. SWANTON, of Columbia University, is visiting the Teton Indians of South Dakota, in order to carry on linguistic researches among this tribe.

PROFESSOR MARK W. HARRINGTON, of the Weather Bureau, who has recently been assigned to stations in the West Indies, has resigned.

WE regret to record the death, on July 2d, of Sir William Henry Flower. Sir William Flower was born at Stratford-on-Avon in 1831, and was educated at University College, London. He served as assistant surgeon during the Crimean War, and later was for two years assistant surgeon in the Middlesex Hospital. He then became conservator of the Museum of the Royal College of Surgeons, and in 1870 he was elected Hunterian professor of anatomy. This chair he held until 1884, when he became Director of the British Museum of Natural History. He resigned the directorship in 1898 on account of ill health. His contributions to science are numerous and important; chief among these are the 'Introduction to the Osteology of Mammalia,' the third edition of which appeared in 1885; 'Introduction to the Study of Mammals, Living and Extinct' (1891); 'The Horse, a Study of Natural History' (1892); and 'Essays on Museums' (1898). Sir William Flower was a Past President of the British Association for the Advancement of

Science (1889) and of the Anthropological Institute (1883–85), and was at the time of his death President of the Zoological Society of London. He was a Knight of the Prussian order 'Pour le mérite,' a correspondent of the Institute of France, and held honorary degrees from a number of learned institutions.

We learn from *Nature* that news has been received of the death of Mr. John Whitehead while on a scientific mission in the Island of Hainan. Mr. Whitehead left England in the autumn of last year for the purpose of exploring the less known islands of the Philippine group and obtaining a collection of their fauna for the British Museum (Natural History).

The death is announced of Sir Alexander Armstrong, F.R.S., the discoverer of the Northwest Passage. Sir Alexander spent five successive years in the Arctic regions in the search for Sir John Franklin. From 1869 to 1880 he was Director-General of the Medical Department of the British Museum. He was the author of 'A Personal Narrative of the Discovery of the Northwest Passage,' and 'Observations on Naval Hygiene.'

Mr. Henry Wollaston Blake, a well known engineer, died on June 28th. Mr. Blake had been Fellow of the Royal Society for fifty-five years. He was an original member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers, and of the British Association.

We also regret to record the death of Lieutenant Charles William Baillie, Superintendent of the Marine Department of the Meteorological Office of Great Britain, and of Dr. Hugo Weidel, professor of chemistry in the University of Vienna.

Professor William Libbey, of Princeton University, has gone to Sidney, Nova Scotia, whence he will embark on about the 20th instant on the steam whaler *Diana*, of the Peary relief expedition, for Inglefield Gulf. Professor Libbey is accompanied by Dr. A. E. Ortmann, of Princeton University. Among other scientific work they intend to carry on deep-sea dredging.

Dr. Robert Stein, of the United States Geological Survey, accompanied by Dr. Leopold Kann, has also arranged to embark with the expedition, leaving Sidney, Nova Scotia, about July 20th, for exploration in Ellesmere Land. They plan to spend the autumn in surveying and collecting along the coast, and to winter on the island.

During the present year field work of the Jesup North Pacific expedition of the American Museum of Natural History is being carried on in the State of Washington, in British Columbia and in southeastern Siberia. It is expected that Dr. Berthold Laufer will bring his researches on the Island of Saghalin and on the Amoor river to a close during the autumn of the present year. Mr. Harlan I. Smith is conducting an archæological investigation of the shell heaps of Puget Sound, and will, later on, continue his work in southern British Columbia. Mr. James Teit is carrying on ethnological researches among the Lillovet Indians.

The Anthropological Department of the American Museum of Natural History has sent out two investigators to conduct researches among the Indian tribes of the West. Mr. Roland B. Dixon, assistant in anthropology at Harvard University, is visiting the Concow tribe of California, and Mr. Alfred L. Kroeber, fellow in anthropology at Columbia University, is visiting the Cheyenne and Arapahoe Reservation.

The Belgian Academy of Sciences announces the subjects of its prizes for the year 1900. Five are set in the physical sciences and five in the natural sciences, for each of which a gold medal of the value of 600 frs. is offered. The papers must be received not later than the 1st of August, 1900, and must be written in French or in Dutch. Further details may be obtained from the Secretary of the Academy, Brussels.

The Science Club medal of the University of Wisconsin for the year 1899 has been awarded to Mr. Carol Hambuechen, of Milwaukee, for a thesis entitled 'An Experimental Study of the Corrosion of Iron under Various Conditions.' It is the first award of this medal, which has been designed by Thomas Moring, of London, and is to be awarded annually to the member of the senior class who presents for his thesis the best original investigation.

The Anatomical Society of Great Britain and Ireland met at Cambridge on July 8th.

We learn from the *British Medical Journal* that on June 27th, in the presence of a number of eminent official, academic and scientific men, Virchow formally opened the new pathological museum which bears his name and has been built under his superintendence. It has cost about 560,000 Marks, and contains a collection of more than 20,000 specimens, collected almost wholly by Professor Virchow himself, and representing the history of pathology during the past half century. Professor Virchow delivered a speech in which he pointed out that while foreign countries, especially England, had long preceded Germany in anatomical researches the Fatherland could now rival them on that ground.

At a sitting of the Municipal Council of Paris, M. Bertillon has been dismissed from his position as Chief of the Indentification Service at the Perfecture of Police, owing to his report in 1894 on specimens of Dreyfus's hand writing, submitted to him for comparison with the bordereau by the Minister of War. M. Gobert, expert of the Bank of France, who was first appointed to examine the matter, reported that the bordereau might well have been written by another person than the one suspected. M. Bertillon's report ran as follows: "If one sets aside the hypothesis of a document very carefully forged, it clearly appears that one and the same person wrote the letter (*i. e.*, the bordereau) and the pieces communicated for comparison."

Judge Colt, of the United States Circuit Court, in Boston, has reversed the decision of the Board of Appraisers, which held that surgical instruments imported to this country were dutiable. He holds that the instruments are not dutiable, being 'scientific instruments' within the meaning of the law.

UNIVERSITY AND EDUCATIONAL NEWS.

The *British Medical Journal* states that at the special meeting of the Senate of the University of London summoned for June 28th a long discussion took place upon a motion submitted by the Chancellor (Lord Kimberley) accepting the proposals of the government to transfer the University from Burlington Gardens to the Imperial Institute. The meeting was an unusually large one, and sat for two hours, but finally adjourned without coming to a decision. It is understood that great reluctance was expressed to surrendering the present buildings, but that the majority favored the acquisition of some portion of the Institute buildings to meet the demands of increased accommodation for teaching and laboratory work, such as must speedily follow the passing into law of the statutes framed by the Royal Commission.

At the University of Wisconsin Dr. W. H. Hobbs, assistant professor of mineralogy and petrology, has been promoted to a full professorship, and Robert W. Wood, instructor in physics, to be an assistant professor.

Professor Rush Rhees, of Newton Theological Seminary, has been elected President of the University of Rochester. He will assume office in July, 1900, which will be the fiftieth anniversary of the founding of the institution.

Of the eight fellowships given annually by the University of Virginia, two have been awarded in the sciences as follows: *Mathematics*, T. G. Johnson; *Agriculture*, W. F. Maret. The fellowships are of the value of $300 a year, and each fellow is expected to teach one hour daily in the University and to devote the remainder of his time to advanced study and research.

Professor E. A. Schaefer, F.R.S., for fifteen years Jodrell professor of physiology in University College, London, has been elected to the chair of physiology in the University of Edinburgh.

At a meeting of the Council of University College, London, held on Saturday, June 17th, Professor Montelius was appointed Yates lecturer in archæology for the year 1900.

Dr. Schenck, docent in physiology in the University at Würzburg, Dr. Martin, docent in anthropology in the University of Zurich, and Dr. Blaschke, honorary docent in mathematics in the Technical Institute of Vienna, have been promoted to assistant professorships.

SCIENCE

FRIDAY, JULY 21, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE ROYAL BOTANIC GARDENS AT KEW

THE recent establishment of the New York Botanical Garden, following so closely the development of the Missouri Botanical Garden, through the private munificence of Henry Shaw, and the evident tendency in American cities to establish each its own garden as a means of public pleasure and education, leads one to turn to the Old World, where such institutions are no longer a novelty. There is certain to be in the near future in America an awakening of interest in this feature of popular education, and we predict that the next quarter of a century will see them organized as a part of the park system of every city of importance and as a part of the equipment of every university that merits the name and rank.

Passing by the botanical gardens of the Italian cities, some of which are the oldest establishments of the kind in the world, dating back to the fifteenth century, and the less considerable establishments at Berlin and Paris, it is natural to turn to the largest and in many respects the most important of them all, because of its wide reaching influence, coextensive with British colonization itself. Of English botanical gardens those at Oxford and Cambridge, while smaller than Kew, are much older, and yet their influence largely pertains to the university towns and the universities that foster them, while Kew Garden, far from being local or simply national, is in-

tercolonial and international in its character and influence.

Kew Garden is involved in the history of English royalty, for not only is it situated in the heart of historic England, but itself forms a part of that history, being one of that royal series of palaces and parks that from time to time have bordered the Thames from Windsor to Westminster and have made the very region historic. Of this series, Kew with its gardens has been gradually given to the nation by the crown. Westminster ceased to be a royal residence with the bluff King Hal and his tender but well-beloved son ; the glories of Richmond Palace as a royal residence ended with the giddy but brilliant Virgin Queen, and today only a vestige remains of Richmond's former greatness ; Hampton Court flourished with Queen Anne and William and Mary ; Kew's brief period closed with the decadence of the third Georgian reign, when the poor king, bereft of his colonies and finally stricken with disordered mind, was kept here in retirement during the long regency ; of all the series, Windsor alone, oldest of all, remains a royal residence.

While the public Kew Garden has been established for less than sixty years, the real existence of Kew as a royal botanic garden dates back to the days of the good Princess Augusta, widow of Frederick, Prince of Wales, son of George the Second, and for a long period prior to this a large number of plants from various parts of the world had been under cultivation, and the whole area now occupied by the garden and arboretum was a private royal park with an abundance of native and cultivated trees ; even in the time of Charles the Second the collection of plants was so considerable as to attract much attention, and Kew was regarded as one of the finest gardens in the British Isles. Erasmus Darwin, grandfather of the famous naturalist, sung its praises in his day :

"So sits enthroned in vegetable pride
Imperial Kew, by Thames' glittering side ;
Obedient sails from realms unfurrowed bring
For her the unnamed progeny of Spring."

Soon after 1760 the Princess Augusta, mother of George the Third, with the influence of Lord Bute, himself a botanist of some note, called William Aiton, a Scottish gardener botanist, to take charge of the botanic garden. Every botanist is familiar with the *Hortus Kewensis*, which Aiton published in 1789, in which he gave an account of all the 5,500 species of plants growing at Kew, some of which had never before been described ; among these were a considerable number of our common American wild flowers and ferns, including some of our common violets and trilliums.* The great number of species of plants described in this work gives some clue to the early growth of Kew Gardens, but within the twenty-five years following Aiton's publication the activity in securing new plants was so great that this number was doubled.

On the accession of the present sovereign, the purpose of opening the gardens to the public was carried into execution, and in 1841, Sir William Hooker, a distinguished botanist from Edinburgh, was called to the post of Director, and the gardens were presented to the nation.

Only a small part of the present area—that immediately surrounding the present Temple of the Sun—formed the original public garden, but gradually more and more passed over to the nation until now some 250 acres are included in the public garden, embracing all the former royal park at Kew except the immediate surroundings of Kew Palace and the wild woods immedi-

* This must not be confused with the earlier *Hortus Kewensis* of Hill, published in 1768, nor the second edition published by Aiton's son in 1813. Hill's catalogue named 488 hardy trees and shrubs, some 200 tender shrubs and over 2,700 herbaceous plants. In 1814 the total number of plants under cultivation exceeded 11,000.

ately about the Queen's cottage. Sir William Hooker died in 1866 and was succeeded by his son, Sir Joseph D. Hooker, also an eminent botanist, who still has his room in the herbarium and at 81 is yet active and enthusiastic in botanical work. He resigned his post as Director in 1885, and was succeeded by Dr. W. T. Thiselton-Dyer, who for some time previously had occupied the position of Assistant Director. It is needless to say to those who have watched the growth and widening influence of Kew in the past few years that much of the present development and much of the system manifest in its management, and, above all, its widening influence, is due to Dr. Dyer's versatility and ability as a Director. For ten years past he has been ably seconded in the management of the garden by Dr. Daniel Morris, whose colonial experience in Ceylon and Jamaica, and wide travel throughout the world, has enabled him to direct wisely the colonial policy of the garden. Many New Yorkers will recall his visit here in 1895, and the managers of our own garden owe much to his kindly advice and suggestions on their plans, rendered after an extended visit to Bronx Park.

Kew Gardens are located on the Surrey side of the Thames, on the line of omnibuses leading from London to Richmond and Hampton Court. The seventh mile post from Hyde Park corner is just beyond the Unicorn Gate. Two railways, besides the Thames steamers and omnibuses, connect it with London, and its appreciation by the people is shown by the great numbers of visitors, ranging from a few thousand to a hundred thousand people in a day, the latter crowd only on bank holidays or other special occasions.

The development of Kew Gardens from the first has been a struggle with adverse conditions. In the first place, the park is a flat meadow land bordering on the Thames, and all the slight inequalities of surface that now exist in the garden are artificial, having been made from ancient gravel pits or purposely excavated from the soil. There is little variation in the soil itself, which is generally of poor quality, underlaid by alluvial deposits of sand and gravel, which permit the rapid loss of water by infiltration. Not a rock occurs on the tract, and the rustic rock garden that is now one of the attractive features of the place was artificially constructed from the remains of an old stone building.

In all the features that pertain to natural location and diversity of structure our own Bronx Park possesses vastly superior advantages for a botanical garden by reason of its bogs, its meadows, its rocks, its wooded knolls, its meandering river, and withal a soil that will support its vegetation with far less care than must be constantly devoted at Kew. In fact, Kew lacks all those natural bits of rusticity that are constantly surprising one in our own garden and which the management has wisely determined to protect and perpetuate.

In the second place, the annual rainfall at Kew is less than at almost any other place in the British Isles—in fact, little above one-sixth of the maximum in the United Kingdom. This condition tends to drouth and necessitates a vast amount of artificial spraying; notwithstanding all this, the drouth of the past two summers made the beautiful lawns look brown and bleak, as though it were November instead of July.

Kew Gardens lie in an upward bend of the River Thames as it curves round from Twickenham Ferry to Mortlake, so that the outline is more or less irregular, though the eastern side is nearly straight, being bounded by the narrow road from Kew Bridge to Richmond. All along this road the gardens are shut in by the characteristic ugly brick wall, much like those that shut out the pub-

lic gaze from more than mere glimpses of the beautiful flower gardens of England and render the abrupt brick fronts of the houses more ugly than ever to one accustomed to anything better in the direction of more tasteful architecture. Here, however, the wall is higher than usual, but, fortunately, lacks the usual European *garçon-de-frieze* of broken bottles and window glass. The southern boundary is adjacent to the pleasure ground and deer park of Richmond.

Recently part of the grounds adjacent to Kew Palace have been sufficiently opened up, so that the palace is clearly seen from the Gardens. This old palace, unpretentious and ugly as it is, has its memories in fact and fancy, and its site has an older history still. Here stood the 'dairie house' which in Elizabethan times was owned by Robert Dudley, and here is where Leicester brought his first wife, the unfortunate Amy Robsart, after his marriage at Richmond Palace. Here, in the present palace, was the home of the good Queen Caroline, and here brave Jeanie Deans was brought into her presence by the noble Argyle to intercede for her unfortunate sister. Here the good queen died in 1737, and here George the Third, still wondering why he lost his colonies, passed his last mournful years in comparative solitude. At the rear of the palace, easily visible from the Thames bank and path, is the venerable linden tree, with its dense foliage, under which the children of George the Third were trained in their rustic out-of-door school, and a little farther up the Thames, on what is called 'Queen Elizabeth's Lawn,' is the old stump of the elm planted by the bloody Mary, still managing to put forth a few leafy branches, though merely a fragment remains of its former greatness. A much younger and smaller elm on the same lawn has a girth of nearly twenty-five feet.

Throughout the grounds at Kew are magnificent examples of many native and exotic trees; among the many are the noble oriental sycamore just beyond the old orangery; the weird cedars of Lebanon, near the pagoda; and, what are the most interesting, the black locust and the persimmon standing near the Temple of the Sun, the last particularly a much finer specimen than is usually seen in its American haunts. This group contains, perhaps, the oldest trees in the garden, and a tradition asserts that they were among the number transplanted from the garden of the famous Duke of Argyle. Besides these trees, which are not indigenous to Britain, are the groves of English beeches and elms in places surrounded by soil that has not been disturbed for over two hundred years and producing a spring flora unlike that of any portion of England for miles around. Here and there are magnificent couples of lindens or European oaks, often planted on a slightly raised artificial mound, and at one point there is a lonely row of decrepit elms carefully protected in their old age and known as the 'seven sisters'—tradition telling us that they were planted for the seven daughters of King George; only five of them now remain and some of these are badly battered by time.

Across the Thames from the garden, over a wide stretch of greensward toward which one of the delightful vistas of the garden opens, is the old Syon house, an old monastery and nunnery founded by Henry the Fifth in 1415, but closed for the second time by Elizabeth, and presented by her to the Duke of Northumberland, to whose line it still belongs.* A little farther up,

* This old monastery, like many others, has its quaint history, which has been elaborated in book form. One of its peculiarities, due, perhaps, to the fact that it was occupied by both monks and nuns, was the maintenance of silence, which necessitated the formation of a sign language as elaborate as it was peculiar. From its long series of signs we quote one or two samples:

in the old bit of wild woods in the vicinity, is a quaint old thatched cottage of the sixteenth century, which Elizabeth used to visit with her courtiers and which is still carefully preserved as 'the queen's cottage.' It is not surprising to those who are familiar with the inner history of these times that the lane leading to this cottage and formerly separating Kew Gardens from the Richmond deer park bore the name of 'love lane.'

Among the notable features of Kew Gardens that can be well recommended are the long vistas in the arboretum crossing each other at angles and serving to open up distant features of the garden grounds and thus preventing the massing of the vast crowds of visitors, who would otherwise endanger the glass houses and the tender ornamental plants of the more easily accessible portions. In the construction of these vistas the director has happily adopted the practice of trimming up the lower branches of the lines of trees, thus giving a more perfect appearance of distance and proper perspective to the vista. In the purely decorative portions of the grounds, which, by the way, are somewhat excessive for the scientific harmony of the gardens, there are masses of one sort of flowers in large beds, usually of a conspicuous color, which serve an impressive decorative purpose. The usual monotony of the level ground is varied here and there by shallow sunken areas with light terraces, including ornamental beds. The various buildings, conservatories and museums are widely separated from each other, as a further means of scattering the crowds of people who visit them. The two largest conservatories, the palm house and the temperate house, are over a quarter of a mile apart, and the three museum buildings are at the apices of a triangle whose sides measure 800, 1,100 and 1,500 feet respectively.

"Etyng. Pvt thy right thombe with two forefyngers joynd to thy mouthe."

"Fysshe. Wagge thy hande displaied sidelynges in manere of a fissh tail."

The famous flower paintings of the 'North Gallery,' representing the work of the busy but happy life of Marianne North, form a valuable and beautiful adjunct to the collection, as they represent the plants of nearly every flora of the earth exquisitely painted in their native and natural setting, and withal scientifically accurate in their delineation.

The waste steam from the engine house has recently been utilized to warm a small pond in which sub-tropical aquatics appear to be thriving at a latitude where they would otherwise fail to grow in the open, or, at least, fail to produce their blossoms. It surprises one familiar with English climate to see certain species of palms growing out of doors, and the bamboo plantation is one of the instructive features of the garden collection.

Among these praiseworthy features there are others that might be improved upon, and these should be noted. Besides the excess of area where a strictly decorative treatment obtains, there is a stiffness about certain portions, notably the herbaceous ground with its formal rectangular beds and the ugly brick wall that separates it from the rest of the garden. Strikingly in contrast with this, and more striking because of its immediate vicinity, is the rock garden which, though artificial, is really one of the most delightful bits of irregularity in the entire tract. It must in justice be said that some portions of the formality at Kew are inheritances from a royal past. Some of the old conditions seem strange to one of democratic birth; for instance, since a previous visit to Kew, in 1894, the wire fence that used to separate the more recent arboretum from the garden proper has been removed; on one

side of this fence smoking was formerly prohibited, while it was permitted, if not encouraged, on the other side; with the disappearance of the fence has died out the prohibition, for old customs do die even in conservative England.

Another feature lacking at Kew and emphasized by its presence at other places, notably, the gardens at Berlin, is the sharp definition of distinctive floras illustrating the modern principles of ecology. Nowhere could the contrasts of two strange floras be more strikingly shown than in the smaller greenhouse known as the 'succulent house;' here are two peculiar floras magnificently represented, the cactus flora of the Sonoran region of southwest America and the characteristic Euphorbiaceous flora of southern Africa. The geographic contrast of plants closely similar in habit but widely separated in their botanical characters might be most beautifully and forcibly illustrated here, but the opportunity is entirely lost, for the plants are commingled instead of contrasted and only the insignificant labels give to the expert the clue to this marvellous principle of plant distribution, while to the ordinary observer a most effective object lesson is entirely lost. Perhaps it may justly be said that with all their success at colonization, the principles of plant distribution are not so thoroughly grasped at Kew as they have been brought out at the German botanical garden through the skill of Professor Engler and his associates.

The museums, too, at Kew are greatly crowded and one leaves them with confused notions of their significance. This arises: first, from the fact that the buildings are small and two of them are badly broken up into a number of small rooms, and thus are not at all adapted to their present use; secondly, from the enormous mass of material crowded into insufficient space; thirdly, from combining the economic series that attempts to show the legion of plant products useful to man, with the taxonomic series that attempts to show the structural relations of plants to each other; and, finally, from the absence of any modern biological principle governing the arrangement of the collection. Even in the third museum, where the species of woods are illustrated, the collections, because of these features we have noticed, are vastly inferior to the magnificent Jesup collection in the American Museum of Natural History, where the value of rational methods of displaying a collection are added to the intrinsic value of the collection itself. At Kew the arrangement detracts from a collection which is the inferior of our own.

Having thus located Kew Gardens geographically and historically and noted some of its internal features, let us consider some of the results that are accomplished through its agency that we may arrive more happily at the *raison d'être* of the existence of botanical gardens in general.

1. The Kew Gardens represent the best expression of horticultural work in Great Britain. Many of the most noted gardeners in the Dominion, at home and abroad, are men who have been trained at Kew, and a succession of young men and women are continually being trained for this work from year to year. The advantages of such a garden training are evident to young gardeners, and there is always a larger waiting list of applicants than the work required can possibly supply. Kew is recognized as the authoritative center for horticultural work, and, interested as she is in introducing new forms from exotic sources, cannot fail to exert a marked ininfluence on horticulture. Many plants find their way hither for authentic naming, and through the agency of Kew many plants of value for decorative purposes are brought to notice, not only in the British Isles, but throughout the world-wide British colonies.

So large a number of plants are continuously in cultivation at Kew that plant growers from all over the United Kingdom visit Kew for purposes of comparison of plants and methods, so that the Kew authorities are in touch with every plant grower of importance throughout the Queen's dominions.

2. A large and properly named collection of growing plants cannot fail to exert a positive educational influence on the general public. There is an amazing ignorance among all classes regarding the names and relations of trees and shrubs. We know the common animals, even those we see only rarely, but we pass under beautiful trees day after day, many of us, all our lives without recognizing either their names or relations, or noting their marked and positive characters ; we know the common birds even, better than the trees in which they build their nests. A large and diversified named collection of trees and shrubs is, therefore, an educational influence of no small value. And this is more especially true when the plants are selected not merely because they present a mass of brilliant color, nor when they are selected for their mere novelty, as in the case of many private collections of note, but when, as at Kew, they are selected from all parts of the world to represent the distinctive vegetation of different regions, and from the entire range of the vegetable kingdom, and are arranged so as to show geographic (ecologic) and biologic relationships, and most especially when they are supplemented by museums illustrating the economic value of plants and their relation to man and his welfare. As we have said before, Kew is particularly hampered from her lack of suitable buildings for her museums. The three buildings occupied for this purpose were none of them originally intended for any such use. One was the orangery erected for the Princess Augusta in 1761, and bearing her monogram, and the other two were residence houses not in the least adapted to their present use as museums. This has necessitated the combination of the systematic (or more properly taxonomic) and the economic series, and has prevented as consecutive and logical an arrangement as would best serve educational ends. The New York Botanical Garden is fortunate in being able to outline its plans untrammeled by existing conditions other than those imposed by nature, and in arranging liberally for its museum under a single roof in a fireproof building, where its economic and taxonomic series of collections can be displayed, without crowding, on separate floors of the building.

3. The interrelations of Kew with the colonial gardens so widely scattered in both hemispheres and in every zone make possible the broad study of suitable economic plants for cultivation in a particular colony, and, reciprocally, the colonial stations are helpful in enabling the mother garden to know the conditions that exist which will permit the development of certain agricultural industries within their territory. In selecting plants of economic importance for new colonies or in aiding in the renewal of old colonies that have been ruined by neglect; in distinguishing between the varieties of cultivated plants more or less valuable for their useful products; in assisting to prevent the extermination of useful plants that are endangered in their native countries ; in assisting to make more productive the enormous colonial development, and in preventing the destruction of forests that if continued would turn fertile provinces into desert places—in all these important factors of English civilization the Kew Gardens serve an important and useful purpose in advice and direction. The development of the cotton and cinchona culture in India, the agricultural development of Ceylon and the extension of the

area of cultivation of tea are all examples that illustrate the direct benefit of Kew to the English colonial system. And this influence is bound to extend still further. Many of the problems have been settled for the Asiatic colonies, and the Australasian region has begun to develop its own botanical centers; but the vast areas just opening up in the Dark Continent and the problems that will arise in regard to its agricultural development are yet to be worked out. The Anglo-Saxon is the only race that can enter a country, hold it firmly and elevate it in the scale of civilization by making it more productive. France has to face the difficulty of keeping up her own home population, and her colonial development has been comparatively feeble; the Spanish have nearly blighted every country on which they have laid their hand; and recent German attempts seem to merit for them the title of an impracticable people; the Anglo-Saxon blood, English or American, is destined to be the leading colonizing and civilizing spirit throughout the world in the future, as it has been in the past.

4. Aside from the economic features of the garden influence, there are others affecting the development of botany as a pure science that may well be considered. Connected with the garden is the largest herbarium of the world. Here are the types* of all the plants published at Kew from the British colonies; many others that have encircled the globe in every direction and have touched on every mainland and insular coast; others still that have been obtained through the purchase or donation of collections of other than British botanists. Besides these there are authentic if not type specimens derived from miscellaneous sources, in many cases vouched for by the author of the species himself and distributed with his own label.

In this way types or authenticated specimens of probably three-fifths or more of the 135,000 known flowering plants and ferns are here represented, and usually a great number of specimens represent the variations and geographic distribution of all except the rare species. More or less authentic specimens exist of most of the remaining two-fifths of the higher plants, so that the Kew herbarium is the consulting herbarium of every country, and its visitors' list for a year will disclose the names of botanists throughout the world. While at Kew during one summer I met botanists from Berlin, St. Petersburg, Brussels, Geneva, Java, Ireland, Trinidad, the Channel Islands, Arizona and Minnesota, all consulting either the growing collection in the garden or the specimens preserved in the herbarium. The other great European collections, notably the ones at Berlin and Paris,* are important and contain many types and must often be consulted for supplementing the types missing at Kew. The same may be said of other less important European collections, ranging from St. Petersburg to Madrid. The Torrey herbarium at Colum-

* By a type is meant botanically the original specimen from which the species was described when it was first made known. This specimen has a particular value, for if any subsequent question arises regarding the species in question it must be settled by reference to this type. Not unfrequently in the case of plants described from imperfect material the type is a much less complete representative of the plant than specimens collected later, but any question of appeal must be to the type itself.

* It was the writer's opportunity, after spending a summer at Kew, to visit, for a short time, the collection at the Jardin des Plantes. In this way the vastness of the Kew collection, as compared with that at Paris, was more forcibly impressed. At Kew the floras of even the French colonies themselves, collected by Frenchmen themselves, were abundantly represented. At Paris the collection was conspicuous by their absence. Even the series of plants representing the labors of French monographers are vastly better represented at Kew than at Paris. The Berlin collection, owing largely to the efforts of Dr. Engler, is much more important, and, in some directions, is rapidly gaining on its British rival.

bia, the Gray herbarium at Harvard and the National herbarium at Washington are any of them far richer in the representation of the plants of the United States; yet, considered from the standpoint of the world's flora, the collection at Kew is practically equal to all others combined in general completeness and diversity of representation.

The herbarium was formerly housed in another of the royal residences at Kew which adjoins Kew Green, and was called the house of the King of Hanover, because it was once occupied as the residence of that prince who succeeded to the throne of Hanover as George the Fifth.

This house for a long period was the sole repository of the great collections and library of the Kew Garden, but within the past few years the present director has expended a small appropriation in erecting a large three-galleried addition, which now contains all the plants above the ferns, but which is very inconvenient because of the lack of concentration on a single floor and the necessary waste of time in passing from books to specimens and *vice versa*. It is the greatest cause for regret among those who appreciate its value to science that the building is not fire-proof. It is a sad comment on the scientific public spirit of England that her government should permit this invaluable collection to remain in any other than a fire-proof building. The loss of this enormous collection would be irreparable, and would alike affect the botanical knowledge of all the great floras of the globe, from Canada to Tasmania and from Iceland to the Straits of Magellan, wherever British colonial activity and scientific exploration have manifested themselves. To leave such a collection in even the remotest peril from destruction by fire is a national disgrace that the good sense of the English government ought to correct without delay.

The Kew herbarium has for years been under the care of J. G. Baker, well known for his publications on ferns and monocotyledons. Recently he has been succeeded by his able assistant, W. B. Hemsley. George Massee, author of a work on British fungi, is in charge of the lower cryptogams. Besides these the strictly botanical staff consists of six botanists and botanical assistants, a botanical artist, besides some clerical force. The morphological and physiological work is carried on for the Garden under Dr. D. H. Scott, at the Jodrell Laboratory, within the garden enclosure. Besides the regular staff there are other familiar faces at Kew, who may be classed as voluntary workers. These include, besides the former Director, Sir J. D. Hooker, Professor Oliver, the associate and assistant of Bentham; C. B. Clarke, well known for his publications on the botany of India; M. C. Cooke, and others more or less regular.

The publications of Kew have been enormous. The bibliographical list published in 1895 includes over 1,600 titles, varying all the way from a discussion of some useful plant to the flora of a continent, and from an octavo pamphlet to a ponderous folio volume. In 1863 Sir William Hooker projected a series of 'Floras' on a uniform plan in the English language for all the English colonies. This project has been carried on steadily to the present time. Of these the 'Flora Australiensis,' by Bentham, 1863–1878, in seven volumes, and the 'Flora of British India,' by Sir J. D. Hooker, 1875–1894, are the most important that have been completed. At present the force is actively engaged on the 'Flora of Tropical Africa,' probably the most difficult undertaking of all. It is an unfortunate circumstance that while the Germans are actively engaged on a similar work there is simply rivalry instead of cooperation in its elucidation. The colonial rivalry seen in Central Africa at this time between the Germans and the English, as manifested

by rival steamship companies and rival railroads to Lake Nyanza, is likely to be beneficial in opening up to civilization more rapidly larger areas of territory than could otherwise be reached ; but in the scientific publication of the flora of the region rivalry is likely to result in greater harm than good, for a considerable portion of the work of two independent sets of workers is likely to be duplicated. In the matter of building railroads the British are likely to outstrip their rivals, but in the careful and thoughtful working-out of the great problems presented by the flora the more philosophic German is almost sure to make the better showing. The collection at Kew is so extensive that English botanists have too often neglected the opportunity to compare types at other herbaria easily within their reach and have sometimes belittled work that has been accomplished elsewhere; such self-importance always suffers a decline, and in this the Kew botanists might have learned a lesson from the history of American botany in the last quarter of a century. But there is hope for better things, for one of the Kew botanists during the summer of 1897 made a visit to Berlin to compare the types in that herbarium, the first Kew botanist that has visited the Berlin collection since Bentham's time, thirty years ago. It is to be hoped that this visit will result in opening the eyes of English botanists to the facts recognized everywhere else, that more careful and philosophical floristic work is being accomplished at Berlin even with more scanty materials in the collection. Kew, too, is learning how to introduce into her staff men of university training more familiar with modern ideas of botanical study.

Besides the floras above noted, the most important work issued from Kew is *Genera Plantarum*, by Bentham and Hooker, which for the first time brought together compact Latin descriptions of all the genera of flowering plants. It was commenced in 1862 and was completed in 1883, only a short time before the death of its veteran author. This work has not only made possible the study of distant floras of the earth and stimulated the botanical exploration of unknown regions, but has laid the foundations on which the more recent as well as the more logical and complete arrangement has been developed under the editorship of Professor Engler, at Berlin, *Die natürlichen Pflanzenfamilien*.

As a supplement to the *Genera Plantarum*, the botanical world is further indebted to Kew for the *Index Kewensis* in four massive quarto volumes, with the names all the flowering plants that had been described up to 1885, with citation of place and date of publication and geographic distribution. This enormous piece of bibliographic work, involving hundreds of thousands of references, was accomplished under B. Dayton Jackson, Secretary of the Linnæan Society, who spent ten years in its completion, the expense being met by funds left for the purpose by Charles Darwin.

Such is Kew with its beautiful lawns, its delightful shade, its historic associations, its immense collection of cultivated plants, and its wonderful activity in the direction of botanical research. Botanical gardens in America can never have the historic associations of their English rivals, but in this country they will be free from most of the conservative inheritances with which the older gardens are hampered. While they can never possess the ancient types of the early explorers, they can and do possess the equally valuable modern types of more recently discovered species, and their collections will in time become just as representative and more complete for the American flora at least than the one at Kew. Besides their philanthropic and educational value, which is chiefly confined to the immediate vicinity in which they are located,

their general usefulness must be world-wide. Their field of investigation even is not to be confined by the artificial limits of the United States, though much remains to be known of our own flora, even that of the more carefully explored eastern region, and especially among the hordes of lower plants that are just beginning to be disclosed. The whole American continent, from Alaska to Cape Horn, with all that immense dark continent of South America, must be the working field of the American botanist. The investigators of the Old World are naturally more concentrated on the study of their own continent, and are generally agreed to leave America to the Americans. The Spanish Americans have accomplished almost nothing in the development of the knowledge of their own floras or the possibilities of their economic vegetal products. The Anglo-Saxon blood in the New World, as in the Old, must originate and direct all exploration and development, and this will form one portion of the work of American botanical gardens. But the scientific study of the flora is only the foundation, the very necessary first step for subsequent work. The study of the active properties of plants, medicinal or otherwise useful to man, deserves close attention, as the recent discovery of numerous important economic products will testify. The question of extending the already prodigious work of transporting the more abundant products of the tropical zone to the region of the highest civilization forms another problem in which the botanical expert is needed to cooperate; then there are important problems of ecology, of plant physiology and of plant diseases, all of which have a direct bearing on the constant and ever-increasing supply of food and shelter for the human race, and these can only be worked out in the presence of such conditions and such extensive collections of plants as a large botanical garden will afford. An extensive garden, with a director at its head who is primarily a botanist with the widest possible acquaintance with plants and who understands in in what directions botanical science needs to be developed so as to prove most beneficial to the race at large, and with departments of research so endowed that skilled botanical experts in their exclusive specialties can prosecute their investigations free from galling questions of personal support —such a garden is capable of becoming even more influential in democratic America than Kew has become throughout the length and breadth of the Queen's dominions.

LUCIEN MARCUS UNDERWOOD.

ABSORPTION IN VERTEBRATE INTESTINAL CELLS.

THE lining membrane of the vertebrate intestine consists of a single layer of cells. These cells are of two kinds. Designating them according to their form, the accepted nomenclature is Cylinder cells and Goblet cells. Certain authors have, however, adopted a nomenclature based on physiological differences and term them Protoplasm cells and Mucus cells.

The Cylinder or Protoplasm cells are typical epithelial elements. They have the form of five- or six-sided pyramids, the broad end facing the lumen of the intestine and the narrower end resting upon connective tissue (Tunica propria). Oppel (Lehrbuch der Vergl. Mikr. Anat.) calls the attached end the base and the free end the apex. The apex is characterized by the possession of a striated border, a structure having the appearance of a bunch of cilia. Its true nature is still in doubt. The nucleus is relatively large and situated near the basal end. The cells have no membrane. They are usually several times as numerous as the goblet cells.

The Goblet or Mucus cells have typically a goblet shape, but show great variation in this respect. They are usually described as

consisting of two parts: the Foot, attached to the Tunica propria, narrow, protoplasmic and containing the nucleus; and the Theca, opening into the lumen of the intestine, broad and filled with a secretion termed mucus. The protoplasm of the goblet cells is much denser in texture than that of the cylinder cells, and their nuclei stain more intensely. Two of these cells never occur in juxtaposition, cylinder cells being always interposed.

Closely associated with these two elements, although having only a topographical relation with them, are Leucocytes or wandering cells. These occur in various positions within the mucus membrane, either between or beneath the epithelium cells. In the former position they usually lie in a line with the nuclear row; rather less frequently nearer the lumen of the intestine. In the latter position they are scattered throughout the connective tissue stroma, and may, in the higher vertebrates, form dense aggregations, termed nodules. A nodule consists of a connective tissue frame-work, inclosed by a delicate membrane, the whole closely packed with leucocytes. The nodules may occur singly or in groups, in which latter case they constitute follicles. Peyer's patches are a familiar example of these structures. Their actual position is within the mucosa, but they encroach, on one side, upon the submucosa, and, on the other, may break through the mucus membrane and project into the cavity of the intestine.

The three elements above described make up, in its entirety, the lining of the vertebrate intestine, and it is through them and by their means that food, after being acted upon by digestive fluids, is absorbed and eventually distributed throughout the various parts of the body. Three phases may then be distinguished in digestion: First, the sifting-out of the useful constituents of the food from the useless and the reduction of the former to a condition in which they may pass through the intestinal mucus membrane. Concerning these processes a considerable fund of accurate information has been collected. There is much difference in detail in different groups of animals; but in general, nitrogenous bodies are transformed into peptone, carbohydrates into mono-saccharides, while fats are apparently broken up into a soap and glycerine. The change in the nitrogenous bodies is brought about by pepsin and trypsin. Carbohydrates are acted upon by ptyalin and amylopsin. Concerning fats the customary statement is that they are first emulsified by bile and then analyzed by steapsin. It is noteworthy that the pancreas furnishes enzymes capable of digesting all classes of food. The above doctrine is that generally accepted, and, beyond any doubt, it is entirely correct so far as it goes. But there are reasons for believing that the cylinder cells of the intestine are also of great importance in the furnishing of digestive fluids. Howell (American Text-book of Physiology, 1896), speaking of 'succus entericus,' says: "Upon proteids and fat it is said to have no specific action. * * * Upon carbohydrates the secretion has an important action." Foster (A Text-book of Physiology, Philadelphia, 1895) also mentions the succus entericus, but ascribes very little importance to it. On the other hand, Landois (Lehrbuch der Physiologie des Menschen, 9 aufl., 1896) summarizes the action of intestinal juice (Darmsaft) as follows:

1. Diastatic action.

2. Metamorphosis of maltose into glucose.

3. Conversion of fibrin, fresh casein, raw and cooked meat and plant albumin into peptone.

4. Analysis of fat.

5. Metamorphosis of di- into mono-saccharides.

6. Coagulation of milk.

Thus there are dissenting opinions amongst physiologists, but in this connection it is to be remembered that it is practically impossible to obtain normal intestinal juice. The method consists in cutting out a portion of the intestine and attaching this by both ends to a fistula made in the body wall. In this way admixture with gastric or pancreatic juice is prevented, but the conditions are highly abnormal and negative results with fluid obtained in such a way are of little weight. Moreover, physiologists usually make their experiments on mammals, whereas a study of the lower groups gives support to the view that intestinal cells can secrete ferments having the same properties as those of the stomach and pancreas. Thus, the Cyprinoid fishes lack a stomach and extracts of their intestines can digest fibrin. The alimentary canal of the Cyclostomes is a straight tube, entirely wanting in diverticula. It is, therefore, probably safe to conclude that the view expressed by Landois is essentially correct, although it is not to be understood by this that the succus entericus has anything like so powerful an action as the enzymes from stomach or pancreas. Its properties are the same in kind as these, but much feebler in degree.

The third class of foods consists of fats. These, unlike proteids and sugars, are apparently insoluble in the various digestive fluids. It seems, however, that steapsin is able to saponify fat. That this process actually takes place has been proven by chemical analysis made on the contents of the intestine of animals fed on fat. For this reason, and for others to be given below, it is generally supposed that fat enters the intestinal epithelium as soap and glycerine. The evidence is, however, somewhat contradictory, and this question can hardly be considered absolutely settled.

The second phase of the digestive process, absorption, consists of the passage of the prepared food through the epithelium of the intestine; in reality, its entrance into the body, for hitherto it has been outside. This food, as has been seen, is in solution, and the older physiologists considered its entrance to be either a mere soaking through or else an osmatic process. But it has been shown that this view is erroneous. Without discussing what the actual process may be in intravitam staining, it is known that living protoplasm behaves differently with different stains. Living spermatozoa can be stained differentially, while protozoa will take up certain anilines and wholly resist the action of others. That is, protoplasm has the power of resisting the entrance of certain substances. This power is clearly demonstrated by the epithelium of the intestine. The laws of diffusibility do not hold true. For example, if a solution containing equal parts of sodium sulphate and glucose be allowed to act on the living intestinal mucus membrane, the glucose will be almost entirely absorbed and the sodium sulphate scarcely at all. Yet the salt is much more diffusible than the carbohydrate. The epithelial cells, then, possess a selective power which is obviously dependent upon the activity of their protoplasm. That this is of great importance to the organism needs no emphasizing.

The entrance of proteids and sugars has not been studied cytologically. Such an investigation, although of the utmost importance, presents extreme difficulties. The preliminary process essential to mounting would probably take out of the cells all such substances, and the work would necessarily have to be done on fresh cells. But proteid reactions are obscure and indefinite, and this, along with the technical difficulties in the way, a magnification of 750–1,000 diameters being necessary, has evidently discouraged such researches, and our actual knowledge on this point is nil. Having entered, however, it has been satisfactorily

demonstrated that proteids and carbohydrates are taken up by the blood and that they do not enter the lymphatic system.

Natural fats are mixtures of the three chemical compounds—Olein, Palmatin and Stearin. Of these, the first is a liquid, the other two are solids. Consequently, the proportions in which these three ingredients are mixed conditions the melting point of the fat. Tallow and lard are high in stearin, while cod-liver oil is high in olein. Thus the melting point of fat enables us to form an idea as to what animal produced it. But all fats, of whatever nature, reduce osmic acid, producing an intense black coloration, and this clear and distinctive test furnishes the reason why the absorption of fat has been a favorite study with cell-physiologists. In passing a piece of intestine tissue through the various processes necessary for its microscopical study all nitrogenous bodies in solution in the cells are very probably dissolved out by the alcohols, but fat is only very slightly soluble in alcohol and not particularly so in cedar oil, and accordingly preparations that still contain a large part of their original fat contents may be studied. The error is more likely to be in the other direction; osmic acid is reduced by all organic matter, and it is extremely probable that many cell aggregates, not fat at all, have, by virtue of their having actually reduced osmic acid, been mistaken for fat.

Taking up now in detail what has been learned concerning the absorption of fat, we find that there are three conflicting theories. These are:

1. Fat enters between the epithelial cells.
2. Fat enters the epithelial cells.
3. Fat enters both ways.

Concerning the first of these views, that the only entrance path of fat is between the cells, it has had, in so far as I have been able to learn, but one advocate (Watney, 1877), and the appearances are so strongly against it that we are probably entirely safe in rejecting it in toto.

With regard to the other views the matter at issue is much more comprehensive than the mere entrance of fat. One of these, the second, holds that the sodium salt of a fatty acid (a soap) and glycerine enter the cell in solution. The reasons for believing this are, first, the general reason that the solids have never been known to enter the intestinal epithelium, and, second, the appearances in the fixed cell. The striated border and a narrow band running across the cell just beneath the striated border are always free of fat.* It first appears lower down in the cell and arises as exceedingly minute globules, which roll together and fuse and eventually come to form masses, which may be so large that two or three fill the entire cell. That is, the soap and glycerine are synthesized, and fat appears in an exceedingly minute state of division. The increase in size of these particles is a merely mechanical phenomenon and has been observed in living cells. At the expiration of a certain period after the commencement of absorption a second process is inaugurated. This has been studied the most carefully in those forms which possess intestinal villi, and the following is applicable to only such. A very fine canal system has been described by some, consisting of vessels that extend from the base of the cell into the lacteal, but more accurate observation has shown that such does not exist. The fat merely passes from the cell, the determining factor in its movement being protoplasmic activity, and becomes scattered throughout the stroma of the villus, lying in a peri-cellular fluid which occupies the spaces between the connective tissue cells and fibers. Heidenhain (1888) has given a very clear expla-

* This has been disputed. Some writers have described fat both in and just beneath the striated border.

nation of the method by which it enters the lacteal. The villus is enclosed externally by the epithelial layer, and its center is occupied by the lacteal. In the space outside of the lacteal and inside of the epithelium there is the connective tissue (in which the fat is scattered) and muscle fibers. These muscle fibers lay along the length of the villus. They are attached to the connective tissue at the base of the villus and inserted in the inside of the epithelial row and in the walls of the lacteal. Now, when the muscle contracts it will pull upon the connective tissue fibers that bind it to the lacteal and to the epithelium, and these, in their turn, pull the epithelium inwards and the wall of the lacteal outwards. The force is the same in both cases, but the epithelium is far more resistant than the wall of the lacteal, and the result is that the volume of the vessel is increased. This causes a negative pressure within the lacteal (valves prevent its filling up from the large lymphatic vessels) and a positive pressure in the stroma between it and the epithelium, and in consequence the peri-cellular fluid, with its fat, is forced to enter it. From the lacteal it, of course, enters the lymphatic system and eventually the blood.

The other theory gives to the leucocytes the primary rôle in the absorption of fat. This holds, in general, that fat, and other food as well, is taken from or from between the cylinder cells by leucocytes and by them carried into the circulatory system. The details are held to be as follows: The eating of a meal brings about great activities on the part of the leucocytes. The number of them in the intestinal walls increases manyfold. This increase is brought about in two ways. There is active cell-division on the part of those leucocytes present in the nodules and scattered throughout the mucosa, and, in addition, there is a migration from other parts of the body. The facts upon which this belief is based are the great increase in size of the nodules during absorption and the presence of innumerable mitoses in the cells themselves. One observer (Schäfer) describes the process for the frog as follows: Beneath the epithelial row the leucocytes divide, the new cell consisting of a nucleus with a minute quantity of protoplasm. It moves either close up to or between the epithelial cells and ingests food. During this process it increases enormously in size and eventually carries the load of food back into the connective tissue, where it enters a lymph capillary. That it is food which the leucocyte carries back, seems to be proved by fat feeding, following which the returning leucocytes contain granules that give the osmic-acid test.

These two theories are contradictory, but not mutually exclusive, for it is conceivable that both processes may take place side by side. Leucocytes are known to ingest foreign substances while in the blood, and, although there are reasons for supposing that this phenomenon is of the utmost benefit to the organism as a whole, it is not supposable that leucocytes have been evolved for the particular function of disposing of pathogenic bacteria. Similarly, in the intestine, the proximity or actual contact of foreign substances in the form of fat globules would undoubtedly provoke activities on the part of the leucocytes. They would ingest such particles freely, but rather for their own individual benefit than for that of the organism as a whole. This would, of course, be of benefit to the organism as a whole, since the return of the leucocytes to the lymphatic system and their death there would increase the amount of food in the lymph, but this conception differs very materially from that which holds that leucocytes function as fat carriers and that without them fat could not enter the lymph. There is, moreover, direct evidence which bears on

this point. Heidenhain has observed that in suckling mammals, which must necessarily be absorbing fat, there are very few leucocytes present in the intestinal mucus membrane. He also throws doubt on the fatty nature of the granules observed returning leucocytes that respond to the osmic-acid test, observing, with considerable point, "Nicht alles ist Fett, was in Osmium säure dunkelt." It is thus possible to bring such observations as these of Schäfer's quoted above into line with the views advanced by Heidenhain. Leucocytes may, as described, divide, migrate out near the surface of the mucus membrane, take up food and convey it back into the lacteal, but the rest of the organism is not dependent upon them.

The third phase of digestion is that which takes place in the cells, and consists in building-up of food substance into protoplasm. This process is of chemical nature and consequently wholly beyond the reach of direct observation. The advances that are being made in the province of organic chemistry lead to the hope that the albumen formula may eventually be discovered, and were this done the synthesis of protoplasm would be at least a theoretical possibility. At present, however, our knowledge of the actual conditions that exist in living matter is so slight that even speculation is useless.

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SCIENTIFIC BOOKS.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, collected during the years 1895, 1896 and 1897. By ARTHUR WILLEY. Cambridge, Eng., the University Press. 4to. Part I., 1898; pp viii+120; pls. 11. Part II., 1899; pp. 85; pls. 12.

The zoological materials collected by Dr. Arthur Willey during his search for the Pearly Nautilus have been distributed to specialists and will form the basis for a series of five or six published parts, the first two of which have already appeared. These of themselves are a substantial acknowledgment to the Board of Managers of the Balfour Studentship and to the Government Grant Committee of the Royal Society, by whose generosity Dr. Willey was enabled to prosecute his researches.

Part I. opens with an account, by Dr. Willey himself, of the anatomy and development of a new species of *Peripatus* from New Britain. The species hitherto described, as Sedgwick has shown, fall into three natural groups, corresponding to their geographical distribution: Neotropical, Australasian and Ethiopean. For each of these Pocock has proposed new generic names. Dr. Willey's new species represents a fourth geographical group, which may be called the Melanesian, and for which he proposes the generic or subgeneric name of *Paraperipatus*, the species being *P. novæ—britanniæ.* As Dr. Willey justly remarks, it is not to be expected that a new species of *Peripatus* would throw much light on the vexed question: Is *Peripatus* an annelid or an arthropod? What is probably needed is something between *Peripatus* and other forms rather than more *Peripatus.*

The Phasmidæ, or walking sticks, have been reported by Dr. D. Sharp. Upwards of twenty species were collected, of which fourteen seem new to science. The report contains an extended account of the eggs and pre-adult stages of these insects.

The scorpions, pedipalpi and spiders were represented by forty-nine species, of which sixteen are stated by Pocock to be species novæ. The descriptions of these include a number of interesting biological notes. The cocooning habits of *Fecenia* and *Ordgarius* are described, and a species of *Conothele* which has subvertical mandibles is shown for the first time to build its nest on trees in the same way as other trapdoor spiders that have this structural peculiarity. In a new species of *Plexippus* the mandibles and maxillæ form a stridulating organ.

Besides this report, Pocock has also contributed an account of the centipedes and millipedes, of which there were twenty-one species, thirteen new to science.

The first part also contains the description of

a new species of Caprellidæ, *Metaprotella sandalensis*, by Dr. P. Mayer, and notes on a little known sea-snake by G. A. Boulenger.

Part II. contains a description of the coral-like *Millepores* by S. J. Hickson. All the specimens are referred to one species, *M. alcicornis*. Material for the study of the soft parts of these delicate organisms was collected. Some of this was found to be infected by what seemed to be a species of *Bacterium*, and which Hickson has named *B. milleporæ*. The nettling capsules were studied in detail, and in some the 'thread' had the form of a delicate tube, in the center of which was a filament. This is probably contractile and brings about the remarkable retraction of the 'threads,' as observed by Dr. Willey in the living animal.

Of the crinoids, sea urchins, star fishes and brittle stars thirty-nine species are reported by F. Jeffrey Bell, almost all of which were well-known forms. Of the twenty-four species of sea-cucumbers collected, F. P. Bedford reported two new to science.

None of the twenty-three species of Sipunculids obtained were new, a fact accounted for by Shipley from the circumstance that the two largest collections of these worms ever made, namely, those of Semper and of Sluiter, were made in the same general region as that in which Dr. Willey worked. While such an outcome may be disappointing to those who are ambitious for the description of new species, it is reassuring in that it shows that a piece of zoological work once well done need not be repeated.

Fourteen species of solitary corals are recorded by J. S. Gardiner, and of these no less than eleven are new. Gardiner also contributes a paper on the post-embryonic development of one of these, *Cycloseris*, in which the close affinity of this genus with *Fungia* is emphasized. Of the thirteen species of fleshy corals of the family gorgonaceæ reported by I. L. Hiles five are new.

The earthworms were studied by F. E. Beddard. Some were too immature for certain identification, but among the well-developed specimens nine species were recognized, three of which were new.

The second part is fully equal to the first and is especially noteworthy for the success with which photography has been used in its illustrations. The photogravure plate accompanying Gardiner's paper on *Cycloseris* is remarkable for the sharpness of its detail; the naturalness of the figures exceeds that found in the best hand lithography. The photographic prints which illustrate Hickson's paper on the *Millepores* give an idea of the nature of the material collected, which in the case of these extremely variable animals could be obtained by no other method. The authors and publishers alike are to be congratulated on their successful use of photography.

So far as the present work is concerned, such criticism as may be offered touches rather the whole undertaking than any particular part thus far completed. While it may be gratifying to an explorer to see the results of his collecting and personal investigation in the form of a compact whole, it is not always certain that this is the best way in which to make it accessible. Such publications are dependent largely on subscription for their circulation and necessarily fall much behind the better class of scientific journals. Since, as in the present case, they contain the first descriptions of many new species, their relative inaccessibility is often a serious obstacle to succeeding investigators. It is to be regretted that all the present series of contributions could not have found places in some of the current zoological journals, as, in fact, some have, thus, in a measure, assuring the accessibility of their contents.

G. H. P.

Traité élémentaire de mécanique chimique, fondée sur la thermodynamique. By P. DUHEM. Vol. III.; 18x25 cm.; pp. 374. Vol. IV.; 18x25 cm.; pp. 381. Paris, A. Hermann. 1898 and 1899.

Vol. III. treats of homogeneous mixtures and solutions with only one volatile component. The opening chapter deals with the thermodynamic potential of a homogeneous mixture. This is followed by one on the state of dissolved substances and by another on dilute solutions. Next in order comes osmotic pressure, and then we find chapters on the hypotheses of Van't Hoff and of Arrhenius, and on the mass law.

The second half of this volume is given up to a discussion of equilibrium in systems containing one solution phase and at least one solid phase.

Volume IV. is devoted to what Duhem calls 'double mixtures' and to general equilibrium in heterogeneous systems. By 'double mixtures' Duhem means two component systems containing at least two phases of variable composition. Under this head come fractional distillation, critical states of mixtures, liquefaction of mixed gases and systems containing two liquid phases. A great deal of space is devoted to a consideration of the alleged law that the vapor-pressure of a dineric system is the same as that of the more volatile component. The volume closes with a general discussion of the phase rule, in the course of which it is pointed out that the classification followed throughout the four volumes has been based on the phase rule and that all good classifications must be so based. This is very satisfactory, but it would have been more satisfactory if we had been told this at the beginning of the first volume instead of at the end of the fourth. One great fault in all of Duhem's writings is his refusal to tell the reader what is to be proved. The result is that the reasons for the single steps do not become clear until the second reading. From the Baconian point of view it is very pretty to marshal the facts in a splendid array and then to point out the general law of which they are special illustrations, but Bacon is not famous as a successful writer of text-books. It would have been very much simpler to have deduced the phase rule and then to have pointed out the way in which it should be applied. As far as the qualitative equilibria are concerned, this is also the historical method. Gibbs deduced the phase rule as a general theorem, and Roozeboom has, since then, shown its value as a guide.

These four volumes of Duhem's constitute a monumental work and will be of immense service. On the other hand, it would easily be possible to overestimate their value. What we have is an exhaustive study of chemical equilibrium put into mathematical form and expressed in terms of the thermodynamic potential. This application of mathematics to chemistry is unfortunately more ornamental than useful. There are myriads of formulas, but very few can be applied to any concrete case. The book is really only a mathematical outline in which formulas are indicated. The equations contain unknown functions. To the experimental theorist the book is a joy and a sorrow, a joy because it points out so much and a sorrow because it always stops short of becoming practical. One of the most striking features about Helmholtz was the fact that he cast his theoretical speculations into such a form that they could be tested quantitatively. Duhem has never done this in physical chemistry. He has done brilliant work, but his theory has always been qualitative and not quantitative theory. If anyone doubts this he has only to read the four volumes of the *Mécanique chimique* and he will be convinced.

WILDER D. BANCROFT.

Le céramique ancienne et moderne. Par E. GUIGNET et EDOUARD GARNIER. Paris, Felix Alcan, 108 Boulevard Saint-Germain. 1899. 8vo. 69 figs. Pp. 311.

This volume is No. 90 of the series 'Bibliothèque Scientifique Internationale,' edited by M. Em. Alglave. Its authorship is in collaboration by MM. E. Guignet and Edouard Garnier. The work consists of two grand divisions, the first, by the Director of the Dyeing and Coloring Department of the Gobelin and Beauvais Tapestry Manufactories, relates to the fabrication of ceramics; the second, by the Conservateur of the Museum of the Pottery and Porcelain Manufactories at Sevres, is on the history of Ceramics.

The first part deals with the material of which pottery and porcelain is made, describes it at length, shows the differences between the different products, gives by analysis the component parts of the various materials required for these products, and describes their mode of treatment and preparation for use. It presents by elaborate definitions the different kinds of ceramics, and shows principally by chapters, the differences between pottery, faience and porcelain. It represents by description and diagram the machinery used in the treatment of the material, in the fabrication and forming of the objects, and the ovens in which they are baked.

This part of the work is interesting and valuable, showing, as it does in detail, the different kinds of ceramics and wherein that difference consists, a branch of the art which has been neglected by amateurs generally and for whose enlightenment this part of the work will be specially valuable.

The second part deals with the history of ceramics. Its primary divisions are by the different kinds of pottery: mat, varnished, enamelled, fine, and ends with porcelain. Within the purview of each of these chapters, geographic subdivisions are made and the ceramics of the respective countries described. The processes of manufacture are not touched upon in the second part.

THOMAS WILSON.

A Short History of Freethought, Ancient and Modern. By JOHN M. ROBERTSON. London, Swan Sonnenschein & Co., Ltd.; New York, The Macmillan Co. 1899. Pp. xv + 447.

Those who know Mr. Robertson mainly for that perfervid, not to say intemperate, though able book, 'Buckle and his Critics,' will likely enough be swift to shun this new work. Its title and Mr. Robertson's previous performance certainly give ground for summary suppositions as to to the contents of the 'Short History.' It ought, therefore, to be said at once that our author contrives to keep his balance here, for the most part, and has produced a book which is well worth reading and studying. Of course, like the majority of self styled 'freethinkers,' he is not nearly so fundamental as he supposes, and still occupies a standpoint which, though fashionable and influential more than a century ago, does little to further 'freethought' to-day, and much to discredit it. Nevertheless, he does attempt to maintain a scientific attitude, and, on the whole, he does not allow preconceptions to run away with him completely. This at least is something to be thankful for. His careful citations, too, are much to be commended, even although he often contrives to cite as authorities some curiously lop-sided performances.

The book covers an enormous range. This is due to the definition of 'freethought' proposed in the introduction and faithfully upheld throughout. "For practical purpose, then, 'freethought' may be defined as a conscious reaction against some phase or phases of conventional or traditional doctrine in religion—on the one hand, a claim to think freely, in the sense not of disregard for logic, but of special loyalty to it, on problems to which the past course of things has given a great intellectual and practical importance; on the other hand, the actual practice of such thinking (5)."

Following out this definition, the work consists of sixteen chapters; these deal with primitive 'freethinking,' with 'freethought' in the ancient religions, in Israel, in Greece and Rome, in early Christianity, in Islam, in the Middle Ages, the Renaissance and the Reformation. Thence the author passes to modern 'freethought'; deals with the English deistic movement, Cartesianism, and the conditions preceding the French Revolution; takes a peep at the United States, and then, in a long chapter, the most interesting of all, discusses the 'culture forces' of the nineteenth century. The conclusion is a brief, and inadequate (in the sense of being sadly out of perspective), review of the present state of thought in the nations. Considering the range covered, and the extent to which secondary authorities are necessarily relied upon, the author's management of his material is deserving of the highest praise. It would be a good thing were the average 'orthodox' to peruse the book carefully—nay, to have it beside them. It might open their eyes to not a little which, as matters now stand, they seem never to fathom.

Naturally, in so extended a study Mr. Robertson has his lapses, and it is interesting to note that these accumulate precisely in the period which he knows best—the modern. Bias here plays its unavoidable part. Of Voltaire we are told that his 'sheer influence on the general intelligence of the world has never been equalled by any one man's writing' (338). On p. 344 we are informed that Rousseau, 'though not an anti-Christian propagandist, is distinctly on the side of Deism'; on p. 354, when another purpose is on hand, we are surprised to learn that he was 'devoutly theistic.' The 'Critique of Pure Reason' is said to be 'definitely anti-religious' (388), a statement sufficiently extra-

ordinary, but outdone a little later, when we learn that the modern movement 'back to Kant' was one of religious compromise! On the other hand, Mr. Robertson has some excellent things. His view of the English deistic movement, as against Mr. Leslie Stephen, is thoroughly sound; similarly his summary of the defects of 'higher criticism' (407) is full of point; while here and there we meet with illuminating remarks, such as that it is 'the tendency of every warlike period to develop emotional rather than reflective life' (409); and that 'the abstention of later specialists from all direct application of their knowledge to religious and ethical issues is simply the condition of their economic existence as members of university staffs' (408). As one looks around upon professorial philosophy, is not this all too true?

Taking the author at his own word, and remembering the limits distinctly laid down in the preface, the book is an excellent one, and it ought to find its way into many hands. It will startle the smug obscurantist, and will afford the free man—who is much more common than Mr. Robertson thinks—many cues to follow up in further reflection. If the author would put his eighteenth century rationalism behind his back, he might produce a definitive history, not of free thought—for all *thinking* is free by the nature of the case—but of man's gradual rise to a more fully reasonable explanation of himself and his environment.

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SCIENTIFIC JOURNALS AND ARTICLES.

The *American Journal of Science* for July contains the following articles:

Velocity of Electric Waves in Air; by G. V. Maclean.

Spiral Fulgurite from Wisconsin; by W. H. Hobbs.

Chemical Composition of Parasite and a new occurrence of it in Ravalli Co., Montana; by S. L. Penfield and C. H. Warren.

Estimation of Iron in the Ferric State by Reduction with Sodium Thiosulphate and Titration with Iodine; by J. T. Norton, Jr.

Mouth of Grand River; by E. H. Mudge.

Electrical Measurements; by H. A. Rowland and T. D. Penniman.

Reflection of Hertzian Waves at the Ends of Parallel Wires; by Lee DeForest.

In a thesis entitled 'An Experimental Study of the Corrosion of Iron under various Conditions' accepted for the degree of Bachelor of Science in Electrical Engineering, in the University of Wisconsin, Mr. Carl Hambuechen shows that whether an iron surface which has been subjected to corrosive influences has a uniform corrosion, local pittings or corrosion along definite lines or curves is dependent upon the physical and chemical character of the iron. The conclusion is drawn that a study of such corroded surfaces, which may be produced quickly by electrolytic means, may give considerable insight into the properties of iron. The main part of the thesis deals with an investigation of the energy expended when iron is subjected to strain, part of the energy being expended in heating the iron, but the greater part being stored in the metal and manifesting itself in an increased tendency to corrosion and a higher electromotive force of contact between the iron and an electrolyte. Measurement of this increase of electromotive force while the iron was subjected to increasing stresses showed that a curve giving relation between stress and electromotive force is obtainable; this curve being similar to the stress-strain diagram, and each curve showing clearly the point of elastic limit. The fact that a metal under stress has a greater chemical activity will afford an explanation of many peculiar cases of corrosion, such, for example, as the peculiar appearance of hardened steel which has been subjected to electrolytic corrosion.

In an article on Russian Museums, Mr. F. A. Bather thus discusses the question as to whether or not museums should send out collections for study: "The occasional loss of a specimen is nothing as compared with the increased value of a properly worked-out collection. If a museum is unable for any reason to send out collections to specialists, then it must have a large and properly paid staff. It is the business of a museum to encourage culture and to be a headquarters of intellectual activity in its various departments. A slight experience serves to show that the museums which prosper

are those which enter into the most cordial relations with a large body of students.''

IN the June number of the *Journal* of the Boston Society of Medical Sciences Dr. James H. Wright has a paper on the application of color screens to photomicography, in which he shows that by a proper use of filtering light media the clearness and accuracy of photomicrographs may be greatly enhanced.

SOCIETIES AND ACADEMIES.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, May 2, 1899.—Mr. A. W. Grabau gave a *résumé* of the paleontology of the Boston basin.

Geological Conference, May 9, 1889.—Under the title 'Tertiary Granitic Intrusives of the Yellowstone Park,' Dr. T. A. Jaggaer, Jr., reviewed Mr. Arnold Hague's paper on 'The Tertiary Volcanoes of the Absaroka Range' (SCIENCE, IX., pp. 425–442).

Students' Geological Club, May 16, 1899.—At a special meeting of the Club, Mr. L. LaForge exhibited his collection of Chemung fossils.

Geological Conference, May 23, 1899.—Three papers were presented at this final meeting of the year. Mr. A. W. Grabau discussed 'Some Modern Stratigraphic Problems' from a paleontological point of view. He emphasized the importance in paleontological work of the division of marine organisms into Plankton, Nekton, Benthos, Meroplankton and Pseudoplankton, and held that extensive deposits of planktonic organisms enclosed by beds of shallow water origin indicate a period when the land stood at baselevel. Benthonic animals are important as facies fossils, and the benthonic mode of living exerts a great influence in the development of local faunas. Repopulation of a district by a benthonic fauna which has occupied it at an earlier date—through the medium of meroplanktonic larvæ, as demonstrated by Walther—was illustrated by examples drawn from the Hamilton of western New York. Graptolites and Ammonoids, as pseudoplanktonic organisms, are important as index fossils.

Among local or provincial faunas acceleration was considered to be one of the foremost means of differentiating species. Thus, the Fusidæ of the Paris basin appear to have developed independently from those of the Hampshire basin of England. In each area a complete, distinct, phylogenetic series has been discovered. These, although parallel, present specific differences throughout; while certain individuals suggest occasional migrations of species from one basin to the other.

In considering the operation of barriers upon migration the case of the genus *Fulgur* was cited. This gastropod has inhabited the Atlantic coast between Cape Cod and the Gulf of Mexico since Miocene time, its northward and southward migration being prevented by climatic causes, due largely to topographic conditions. That their young are not carried to other similarly characterized shores appears to be due to the fact that the veliger stage is passed in the egg capsule, so that in this gastropod the planktonic larva does not exist.

Mr. H. T. Burr gave 'Results of Recent Studies of the Geology of the Boston Basin,' and Mr. L. LaForge spoke on 'The Relation of Dikes, Joints and Faults in Somerville, Mass.'

J. M. BOUTWELL,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

BODY BLIGHT OF PEAR TREES.

IN the spring of 1898 when preliminary studies with* apple canker were begun at this station a few inoculations were made in the limbs of a large pear tree with cultures of *Sphæropsis*, taken from cankered apple limbs. The fungus grew readily at all points of inoculation and produced dead sunken areas of the outer bark, similar to those that are so common on the trunks and larger limbs of pear trees. These definitely outlined and sunken areas of dead bark, commonly known as body blight, have long been thought to be due to the action of the pear blight bacillus. However, it may be pointed out that body blight is preëminently a disease of the outer bark, while with pear blight the reverse is true since the cambium layer is first attacked.

* SCIENCE, Vol. VIII., pp. 595 and 836.

The full significance of the result of these inoculations was not realized at the time since it was not then known that *Sphæropsis* occurred on these blighted areas. In the spring of the present year, however, a *Sphæropsis* was found to be comparatively abundant on the diseased bark of pear trees in the station orchards. Since that time a large number of pear trees from various localities affected with body blight have been examined and in nearly every instance this fungus was found to be more or less abundant. One case particularly worthy of notice was that of a comparatively young orchard that was severely attacked by body blight and the fruit of a *Sphæropsis* was so abundant that the conclusion was irresistable that this fungus must be the cause of the disease.

Numerous inoculations made this spring with cultures of the *Sphæropsis* in large trees and in nursery stock clearly show that this fungus may produce body blight of pear trees.

Other species of fungi closely associated with the *Sphæropsis* frequently occur on trees attacked by body blight, *Macrophoma malorum* (Berk.) Berl. et Vogl. being specially abundant. The studies have not yet progressed far enough to determine what part these other fungi play in producing the diseased condition. Bacteria may also be concerned in this trouble, but of this we have as yet no proof.

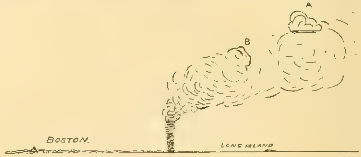
W. Paddock.

Geneva, N. Y.

FORMATION OF CUMULUS CLOUDS OVER A FIRE.

In Science of January 8, 1897, Mr. R. DeC. Ward describes the formation of cumulus clouds over a fire in Cambridge. Last Friday (June 30th) another phenomenon of this kind was observed at Blue Hill and from Winthrop and approximate measurements of the height obtained.

The fire was in South Boston and consumed the buildings of the Bay State Iron Works. The smoke cloud was not of unusual size, but rose vertically to a considerable height (800 to 1,000 metres), encountering at this height a northwesterly wind, which swept it nearly horizontally over the harbor. The fire began before 8 p. m., and the smoke reached its greatest height about 8:05 p. m. At 8:03 p. m. a small white cloud began to form at the apex of the smoke, which at this time was apparently nearly over Long Island, in Boston Harbor. The cloud increased rapidly in height, assuming the form of a true cumulus and reaching its greatest size at 8:05 p. m. The accompanying sketch shows roughly the appearance of the smoke and the cumulus at that time. The sky



CUMULUS FORMING OVER FIRE, JUNE 30, 1899.

was nearly clear, no other low clouds being in the vicinity of the smoke. The cumulus cloud is shown at (A) and apparently was about 3° in height and length, the highest or thickest end being toward the north. Between 8:05 and 8:07 p. m. another smaller cloud formed at the edge of a rift in the smoke considerably lower than the one just described. Its position is shown at (B). Mr. A. E. Sweetland, of this observatory, who at this time was in Winthrop, about 5 miles (8 kilometres) northeast of the fire, estimated the altitude of the highest cumulus to be 15°, while a measurement made with the nephoscope at Blue Hill, about 10 miles (16 kilometres) south of the fire, gave 10° as its altitude as seen from the observatory. These measurements show that the vertical height of the top of the cloud at A was at least 2,500 metres, while that of the cloud at B was about 2,000 metres, above sea level.

The smoke began to diminish in quantity at 8:07 p. m. and separated from the clouds, which became flatter and more elongated. At 8:11 the clouds were separated from the smoke by a space several degrees wide, and after this time they slowly evaporated.

S. P. Fergusson.

Blue Hill Observatory, July 1, 1899.

A REPLY TO MR. MARLATT'S ARTICLE ON SOURCES OF ERROR IN RECENT WORK ON COCCIDÆ.*

When I lived in Colorado, some years ago, I remember hearing it said that a man who had

*Science, June 16, 1899, pp. 835–837.

been there six months knew all about the weather, but one who had been there six years never knew anything about it. A similar paradox is common in biological science; and hence it results that Mr. Marlatt, who has only recently begun the study of Coccidæ in detail, is much more sure about the nature of their specific characters than the present writer, who has been occupied with these insects for eight years. If there is one thing which the detailed study of species teaches, it is that *no man can prophesy beforehand what characters are going to prove specific and what variable.* When the material available is scanty it is largely a matter of guess work to pick out the specific characters, and the majority of new species proposed must be regarded in a sense as provisional. Indeed, the conditions for the absolute proof of the validity of a species are rarely fulfilled, since it has to be demonstrated that nowhere in its whole range does the alleged species intergrade with any other. Let the ornithologist of the Middle States, familiar with the yellow-shafted *Colaptes*, go to the Far West and find there the red-shafted species, *C. cafer*. In either locality he may examine thousands of birds, yet the differences are quite constant; the species are indubitably 'good.' But now let him go to eastern Wyoming, and he finds the two inextricably mixed up, and concludes that there is only one *Colaptes* from the Atlantic to the Pacific.

The general statements made by Mr. Marlatt are most of them applicable to the majority of Coccidæ, and so far are neither new to nor unheeded by the authors of the work he criticises. But there are exceptions, more numerous, probably, than most of us imagine. Take the often quoted case of the Jamaican *Aspidiotus aurantii*, which attacks palms and lignum vitæ, but never *Citrus*. This creature is indistinguishable, so far as known, from the pest of the orange tree found in California and elsewhere. Mr. Marlatt cannot fail to see that a distinction of this sort, however troublesome to the systematist, is both of scientific and economic importance. But this form of *A. aurantii* has not yet been proposed as a species, in the ordinary sense of the word, nor has it even any name. Some *varietal* names have been proposed by Maskell and King for a few Diaspinæ which burrowed under the epidermis of plants, and this fact is thus distorted by Mr. Marlatt: "Several *species*, or *subspecies*, of scale insects have been established on accidental variations of this character, as, for example, *Chionaspis furfurus*, var. *fulvus*, King. Examples of the types of this *species*, * * * etc." It really looks as if the writer of the paragraph considered variety, subspecies and species to be synonymous terms!

What has really happened is this: In the course of years past, one after another, new forms of *Aspidiotus* came to the hands of students of Coccidæ. These were examined and, when apparently distinct from others, were described and named, sometimes as species, sometimes as varieties. Some little time ago Mr. Marlatt proposed to make a critical study of *Aspidiotus*, based on the valuable collections of the Department of Agriculture and such other material as could be obtained. Those who had described new species mostly sent their types or co-types, and thus Mr. Marlatt had before him a much better series than any other student, few of the valid species being lacking. The present writer has had the pleasure of going over Mr. Marlatt's work, and gladly testifies that it is excellent and will, when completed, mark a great advance in our knowledge of the genera examined. As might be expected under the circumstances, Mr. Marlatt has detected various errors in the work of his predecessors, and in other cases believes, but cannot prove, that their conclusions are wrong. Several species are to be reduced to varieties or synonyms; some varieties are to be raised to species. For all of this let us be sincerely thankful, but it is not an occasion for running *amuck*. The present writer never sat down to any lengthy piece of work without finding many things to be changed in his own former results and those of others. It is quite useless to hope to avoid error, but by continuous study we may gradually approach nearer and nearer to truth. That is all I ever hope to do or expect of others.

"The writer trusts that the foregoing criticisms will be taken in the kindest spirit, as they are intended, and he does not wish it

to be thought," etc., etc. (cf. Marlatt, l.c., p. 837).

T. D. A. COCKERELL.

N. M. AGRICULTURAL COLLEGE.

POT-HOLE VS. REMOLINO.

TO THE EDITOR OF SCIENCE: In your issue of July 14th you publish a communication from Mr. Oscar H. Hershey, in which he advocates the substitution of the Spanish word 'remolino' for the term 'pot-hole,' as applied to rounded cavities formed by rivers in their rock-beds.

The term pot-hole may not be elegant, but it certainly expresses the object to which it is applied more correctly than would the Spanish word he seeks to adopt in its place. The definition of 'remolino' is a whirlpool, or whirlwind; it is also applied to a turbulent or disorderly mob of people.

While a whirlpool may be the cause of a 'pot-hole,' it would be improper to substitute the cause for the effect.

The fact that the word *remolino* is not properly applied in the Republic of Colombia, perhaps only coloquially, is no justification for the introduction of an incorrect term into American scientific nomenclature.

F. F. HILDER.

WASHINGTON, D. C., July 15, 1899.

NOTES ON INORGANIC CHEMISTRY.

THE pupils and former colleagues of Professor Joly, of the École Normale of Paris, are continuing with good results the researches of Joly on platinum groups of metals. Brizard, of the École Normale, has continued the study of the osmiamates begun by Joly. These compounds were discovered by Fritzsche and Struve half a century ago, being formed by the action of ammonia and caustic potash on osmium tetroxid. The formula assigned was $K_2Os_2N_2O_5$. Joly was led to suspect that the compound contained the NO group, analogous to his nitroso compounds of ruthenium, and partial analyses and its decomposition products pointed in the same direction. Brizard has now confirmed this by complete analyses of the potassium, ammonium and silver salts, and the formula proposed by Joly $KOsNO_3$ is proven correct. The osmiamates are thus salts of the anhydrid of a nitroso acid $OsNO(OH)_3$, which corresponds to a hydroxid of ruthenium $RuNO(OH)_3$ discovered by Joly.

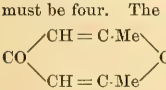
IN the same number of the *Bulletin Soc. Chim.* is a paper by Professor Vèzes, of Bordeaux, continuing his work on the oxalates of the platinum metals. This paper takes up the oxalates of palladium. These may be formed directly by the action of potassium oxalate on potassium chlorpalladite in neutral solution, or by the action of oxalic acid on potassium palladonitrite. Unlike the case with platinum, the same salt is obtained in both cases, a potassium pallado-oxalate of formula $Pd\,(\overline{Ox})_2K_2 3H_2O$. This salt is easily converted back into the chlorpalladite by hydrochloric acid, and into the palladonitrite by potassium nitrite in neutral solution. Professor Loiseleur, of Libourne, has succeeded in preparing the free pallado-oxalic acid. It thus appears, as with platinum, a very close relation subsists between K_2PdCl_4, $K_2Pd(NO_2)_4$ and K_2PdOx_2, and also that the pallado-oxalates are not double salts merely, but 'complex' salts and derivatives of a 'complex' pallado-oxalic acid.

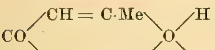
PROFESSOR VÈZES has also contributed to the *Zeitschrift für anorganische Chemie* a short note on the volatilization of osmium in a stream of oxygen. The paper was occasioned by an article by Sulc on the same subject, showing that osmium is volatile at ordinary temperatures. Vèzes calls attention to the fact that Deville and Debray had long ago noticed this fact, which was further studied by Joly and himself. The volatility of osmium depends not only on the fineness of its division, but also upon the method of its preparation, some forms being volatilized appreciably at quite low temperatures.

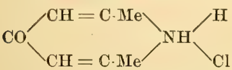
THE so-called 'metallic' variety of phosphorus is shown by D. L. Chapman, in the *Proceedings of the Chemical Society* (London) to be identical with red phosphorus, their appearance under the microscope being similar. The alleged higher vapor tension of some varieties of red phosphorus is merely due to impurity. The vapors from red and from ordinary phosphorus are identical, and at the temperatures of boiling mercury and of boiling sulfur show a

density which corresponds to a molecule containing four atoms at the fusing point of potassium iodid; red phosphorus under pressure is converted into ordinary phosphorus.

THE *Proceedings* for June 1st contain the abstract of a paper by J. N. Collie and T. Tickle, which, while dealing with an organic substance, has a direct bearing on the valence of oxygen. Dimethyl pyrone acts as a base in forming a large series of salts by the direct addition of acids without elimination of water. The chloroplatinite is also formed. From this the inference is drawn that the oxygen is the base-forming element and that its valence in the salts must be four. The formula of the base is

 and of the salts

, corresponding in every way to the salts of dimethyl pyridone, as

. As there seems to be in the compound no other element which can be base-forming, it would seem that oxygen must be added to the list of base-forming elements, nitrogen, phosphorus, sulfur and iodin, and that we now have oxonium bases.

FLUORIN has been given as present in analyses of some mineral waters, as those of Mont Dore and of St. Honoré les-Bains. F. Parmentier has made a careful examination of these waters, and his results, published in the *Comptes Rendus*, show that no fluorin is present. The etched appearance of glass vessels in which these waters have stood is shown to be due to the deposition of silica, of which a considerable quantity is present in the waters, and not to any real etching or the deposition of any fluorin compound.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

FOEHM WINDS.

IN the *Meteorologische Zeitschrift* for May, Billwiller gives a clear and concise account of the various kinds of winds which he believes should be classed together as *foehm winds* (*Ueber verschiedene Entstehungsarten und Erscheinungsformen des Föhms*). There are five varieties in all. The first is the best known of all, viz., the *foehm* on the northern slopes and in the northern valleys of the Alps, which occurs during the passage of an area of low pressure across central and northern Germany. It is this warm, dry wind which is so important a factor in the climate of some of the Swiss villages, Meiringen, for instance. Its rapid evaporation of the deep winter snows has gained for it the name of *shneefresser*. The north *foehm* on the southern side of the Alps is the second class, which occurs when barometric minima move across the northern Mediterranean region and thus draw down the air from the mountains, or when a barometric maximum is forming or approaching on the northern side of the Alps, thus producing a considerable gradient to the south. A simultaneous appearance of *foehm* winds may take place in both northern and southern Alpine valleys when there is a well-marked descent of the air over the mountains. This gives rise to the third class of these winds. Under the influence of the Alpine topography the slow down-settling of the air within an anticyclone may become locally hastened, and thus there results a development of air currents dynamically warmed, which constitute the fourth class of *foehm* winds. Lastly come the dry, *foehm*-like winds which have occasionally been noted as blowing out of winter anticyclones in cases where there is no effect of topography. Although the immediate cause of the occurrence of these warm and dry winds may be different in different cases, this does not affect the nature of the *foehm* itself. A distinct division cannot well be made between the various classes and the term *foehm* should, therefore, be used to describe the characteristics of the winds, rather than their immediate cause.

LIGHTNING AND THE ELECTRICITY OF THE AIR.

UNDER the title, *Lightning and the Electricity of the Air*, A. G. McAdie and A. J. Henry, of the U. S. Weather Bureau, have prepared a report which has been issued as Bulletin No. 26, of the Weather Bureau. This Bulletin consists of two

parts, the first of which, by Mr. McAdie, deals with the electrification of the atmosphere and the measurement of the potential of the air—auroras and protection from lightning. Mr. McAdie has made himself an authority on lightning in this country, and whatever he has to write about lightning always finds large numbers of attentive readers. Most of Mr. McAdie's portion of this Bulletin has previously been printed. Part II., by Mr. A. J. Henry, deals with matters of very general interest, viz., loss of life and of property by lightning; character of soil as influencing lightning strokes; kind of trees struck by lightning, and the question, is the danger of lightning stroke increasing. The Bulletin is illustrated by means of a considerable number of views of lightning flashes and of damage done by lightning, and will doubtless prove interesting and profitable reading to a great many persons.

HEAVY RAINFALL IN THE CAMEROON MOUNTAINS.

The extraordinary rainfall at the base of Cameroon Peak (13,369 ft.) is made the subject of a brief communication by Hann, in the May number of the *Meteorologische Zeitschrift*. The mean annual rainfall at Debundja (Lat. 4°8′ N.; Long. 9°0′ E. approximately), altitude 16 ft., as determined by three years' observations, is about 370 inches. This rainfall shows a double period, viz., a maximum in June and a second maximum in September. At Bibundi, 1 km. distant from the ocean and about 10 ft. above sea level, the rainfall in the year 1897 amounted to 412 inches. These rainfalls are only exceeded by the rainfall at Cherrapunji, on the Khasi Hills, in Assam, where the annual amount is 474 inches. Hann is of the opinion that when additional stations are established on the slopes of the Cameroon Mountains, they will show a rainfall equal to that of Cherrapunji.

VERTICAL TEMPERATURE GRADIENT USED ON WEATHER MAPS.

The daily weather map for June 16, 1899, issued at San Francisco by A. G. McAdie, Forecast Official, notes the vertical temperature gradient in the atmosphere in the vicinity of San Francisco at the time of the morning observation. We believe that this is the first instance on record in which data concerning the vertical temperature gradient have been included on a daily weather map. The following is the reference as printed at the base of the map in question: "In the vicinity of San Francisco this morning the vertical gradient of temperature is about one degree increase for 80 ft., up to an elevation of 2,500 ft. The relative humidity at sea level is nearly 100 per cent.; at Mt. Tamalpais, 23 per cent.

RECENT PUBLICATION.

Weather Forecasting: Some Facts Historical, Practical and Theoretical. Willis L. Moore, Chief of U. S. Weather Bureau, U. S. Department of Agriculture, Weather Bureau, Bulletin No. 25. 8vo. Washington, D. C., 1899. Pp. 16.

The contents of this Bulletin are sufficiently described by its full title. The matter was first printed in the *Forum* for May, 1898.

R. De C. Ward.

SIR WILLIAM FLOWER.

In an obituary notice of Sir William Flower, whose death we were compelled to record last week, the London *Times* comments as follows on his contributions to museum administration:

The greater part of his active life was spent in the direction of important museums, and the question of their practical organization was one in which he always took a keen interest, and in which probably his best work was done. Both by precept and example he assiduously urged the importance of museums as instruments for the advancement of knowlege, and it cannot be doubted that his efforts did much to dispel the delusion—which even now lingers on in some quarters—that any miscellaneous collection of objects, huddled together in any sort of way, is all that is wanted to constitute a useful museum. In his presidential address to the British Association at Newcastle, in 1889, he treated the subject at length, and particularly emphasized the importance of properly selecting and arranging the specimens exhibited. A museum, he pointed out, can promote science in two ways—by affording facilities for scientific research and by providing opportunities for popu-

lar instruction—and if it is to be efficient its collections must be arranged with reference to the special function regarded as its primary end. It is absurd to set before the ordinary visitor a long series of specimens only differing in the most minute details, while it is equally absurd to ask a student engaged in writing a monograph on some obscure morphological point to be satisfied with a selection of typical forms such as the former would find infinitely more instructive. These views he had an opportunity of putting into practice during the time he was head of the Natural History Museum at South Kensington. The numerous alterations he there carried out in the arrangement and nomenclature of the specimens were attended with excellent results, and the adoption of improved principles of classification, together with the relegation to store-rooms of objects which, though of value for purposes of study, were superfluous in exhibition cases, had the effect of greatly increasing the interest of the museum as well as enhancing its educational usefulness.

During the time he was in charge of the Hunterian Museum Sir William did a great deal to supply the deficiency which existed in this country of materials for studying the physical characteristics of the different races of men, and under his care the collections of the College of Surgeons increased enormously, both in extent and usefulness. For instance, in 1884 they contained 89 more or less complete skeletons and 1,380 crania (not including the Davis collection purchased in 1880), whereas 20 years before they had only 18 skeletons and 242 skulls. To him must be ascribed much of the credit of the increased opportunities thus afforded for the study of the osteological variations of man, for it was largely owing to his alertness and watchfulness that the College seized every opportunity of acquiring specimens, thus in many cases saving them from the destruction and neglect which too often is the fate of small private collections. It need scarcely be added that the objects were arranged and looked after in the most approved manner, an instance of the time and labor he spent on them being afforded by the osteological catalogue he published with carefully verified measurements of no less than 1,300 human skulls.

SCIENTIFIC NOTES AND NEWS.

AT its recent decennial celebration Clark University conferred the degree of LL.D. on the foreign lecturers, Professors Boltzmann, Picard, Mosso, Ramon y Cajal and Forel.

THE Albert Medal of the Society of Arts has been awarded to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics, researches which have, in many instances, developed into useful and practical applications in the arts and manufactures."

PROFESSOR KARL VON ZITTEL has been elected President of the Munich Academy of Sciences in succession to Professor von Pettenkofer.

SIR GEORGE STOKES has been elected a foreign member of the Berlin Academy of Sciences.

WE learn from *Nature* that a civil list pension of 60*l*. per annum has been granted to Mrs. Kanthack "in consideration of the eminent services rendered to science by her late husband, Dr. A. A. Kanthack, professor of pathology in Cambridge University."

THE French Minister of the Interior has sent Dr. Vignes to Great Britain to report upon the ophthalmological methods of that country.

GLASGOW University has conferred the degree of LL.D. on Mr. R. L. Jack, Government Geologist of Queensland.

THE Adams Prize of the University of Cambridge has been awarded to Dr. J. Larmor and Mr. G. T. Walker.

DR. F. KLEIN, professor of mathematics at Göttingen, and Dr. W. Nernst, professor of chemistry at the same university, have been elected foreign members of the Academy of Sciences at Buda-Pesth.

MR. D. L. WILDER has been appointed Assistant on the Iowa Geological Survey.

MAJOR-GENERAL SIR JOHN F. D. DONNELLY, K.C.B., retired on July 3d from the secretaryship of the British Science and Art Department, after 40 years in the public service. In consequence of Sir J. Donnelly's retirement, the Duke of Devonshire, Lord President of the Council, has made the following appointments: Sir George W. Kekewich, K.C.B., the present Secretary of the Education Department, to be

also Secretary of the Science and Art Department; Captain W. de W. Abney, C. B., to be the Principal Assistant-Secretary of the Science and Art Department; Mr. W. Tucker, C.B., to to be the Principal Assistant-Secretary of the Education Department.

Dr. E. von Lommel, professor of physics in the University of Munich, died on June 19th, aged 62 years.

Mr. Richard Congreve, a well-known writer on Comte's philosophy and on social and political subjects, died in London on July 5th.

An International Conference of Horticulturists was opened last week in London. Among American delegates were Professor L. H. Bailey, of Cornell University, and Mr. T. G. Fairchild and Mr. H. J. Webber, of the Department of Agriculture.

Nature states that the prize of 500 guineas, offered by the Sulphate of Ammonia Committee for the best essay on 'the utility of sulphate of ammonia in agriculture,' has been awarded by the judges—Mr. J. Bowen-Jones, of Shrewsbury, and Dr. J. Augustus Voelcker, of London—to Mr. James Muir, County Instructor in Agriculture to the Somerset County Council. Seventy-three essays were sent in.

It is expected the Queensland Parliament will grant £1,000 towards the British Antarctic Expedition.

The estate of late Samuel J. Tilden has finally been settled. The report of the referees shows that the New York Public Library, composed of the Astor, Lennox and Tilden foundations, has received $2,859,000. This is about one-third the sum Mr. Tilden wished to devote to the foundation of a public library.

The Dismal Swamp, 143,000 acres in extent, partly in Virginia and partly in North Carolina, has been bought by lumber merchants who propose to drain it. This would greatly alter the fauna and flora of a region of much scientific interest.

The State Zoologist of Minnesota, Professor Henry F. Nachtrieb, has equipped a houseboat for the study of the fauna of the Minnesota and Mississippi Rivers, particularly the fishes. The houseboat was built at Mankato and started down the river about the middle of May. The party is in charge of Professor U. O. Cox, of Mankato Normal School, and expects to reach the southern border of the State by the first of September. The data and material thus far collected are very satisfactory and encouraging. It is the hope of those interested in the work that this may become the beginning of a permanent station. The party consists of Professor Cox, J. E. Guthrie, Chas. Zeleny, Wm. Kienholz, and occasionally also of Professor Nachtrieb.

The *Botanical Gazette* contains news in regard to botanical excursions as follows: Dr. Charles E. Bessey proposed to visit the foot hills of western Nebraska, collecting specimens and making phytogeographical notes in the region above 1,200 m. altitude. Professor John Macoun is engaged in field work upon Sable Island, 'The Graveyard of the Atlantic.' Later in the season he will examine botanically some of the remote parts of New Brunswick. Dr. J. N. Rose is making explorations in central and southern Mexico. He proposes to make a special study of the genus *Agave* and an investigation of the Tampico hemp industry.

Professor E. M. Shepard, of Drury College, and lately of the Missouri Geological Survey, has returned, says the *American Geologist*, from a trip to the Hawaiian Islands, New Zealand and Australia. He has secured numerous and fine photographs of active volcanoes, coral islands and glaciers.

The steamship *Diana* was expected to sail from Sydney, Cape Breton, yesterday. As we have already stated, it carries supplies to Lieutenant Peary, under the direction of Mr. Herbert L. Bridgeman, New York, and in addition takes three scientific parties: One under the direction of Dr. Robert Stein, which will remain in Ellesmere Land; one under Professor William Libbey, of Princeton University, equipped especially for deep-sea exploration, and one under Mr. Russell W. Porter, of Boston, in the first instance a hunting party.

On behalf of the British government Mr. Francis Mowatt has written to Lord Lister in regard to the National Antarctic Expedition as follows: I am directed by the Lords Commis-

sioners of her Majesty's Treasury to inform you that the First Lord has laid before the Board the memorial signed by your lordship as President of the Royal Society, by the President of the Royal Geographical Society and by other distinguished representatives of various branches of science, by which memorial application is made for a government grant in aid of the expedition now being organized by the Royal Society and the Royal Geographical Society for the exploration of the Antarctic regions. This application has received the careful consideration of her Majesty's government, and I am directed to inform you that they are prepared to ask Parliament for grants amounting, in all, to £45,000 towards the expense of the proposed expedition, provided you are able to assure them that no less than equal amounts will be forthcoming from other sources, so as to enable the scheme to be efficiently carried out. In making this announcement I am to call attention to the latter part of the speech of the First Lord to the deputation which waited on him on this subject, as indicating that her Majesty's government must not be regarded, in making this promise, as inaugurating a new era of more extensive grants than formerly from the Exchequer in aid of scientific enterprises. Rather, it is to be understood that the very exceptional importance of the present scheme, so strongly represented by the deputation, is being recognized by the promise of a special grant. At the present time it is only necessary to add that the applications to Parliament for instalments of the grant will be spread over four years, of which 1900–1901 will be the first.

ALTHOUGH the Paris municipality voted to dismiss M. Bertillon from the Anthropometric Bureau on account of his testimony in the Dreyfus case, the Prefect of Police maintains that this ought not to affect his position as a municipal officer, and it is understood that the resolution will not take effect.

THE anti-vivisection people are arranging an exhibit for the Paris exposition. From a booth documents will be distributed and petitions circulated. It has been proposed to exhibit instruments used in vivisection and models of animals under vivisection.

A DINNER was given by the Folk-lore Society of Great Britain on June 26th, in honor of Professor Frederick Starr, of the University of Chicago. The London *Times* states that Mr. E. S. Hartland, Chairman of the Society, presided, and among others present were Mr. Bryce, M.P., Mr. Andrew Lang, Miss Kingsley, Sir R. Temple, Professor Rhys Davids, Professor and Mrs. Haddon, Mr. Edward Clodd and Professor Ridgway. The toasts 'The Queen' and 'The President of the United States' having been honored, Mr. Lang proposed the health of the guest of the evening. Professor Starr, he said, had conducted several expeditions into the heart of Mexico. He congratulated the University of Chicago on its possession of a professor of anthropology. He confessed that the University of St. Andrews had never yet had a professor of anthropology and was not likely to have one, though Chicago was not founded, like St. Andrews, in the interests of culture. No saint ever dwelt there, so far as he knew, and its University was not the original center of the city. Chicago, had, however, 'taken hold of' culture, and one of the indications of its intention to do so thoroughly was its possession of Mr. Starr as a professor of anthropology. He concluded by proposing the toast with Highland honors, which were duly accorded, amid considerable laughter at the complete incongruity of the preceedings. The chairman announced that the committee of the Folk-lore Society had unanimously elected Professor Starr as honorary member of the Society, and had resolved to ask his acceptance of a set of the Society's publications. Professor Starr responded, expressing his high appreciation of the honor that had been accorded him. Mr. Clodd proposed 'Our Kindred Societies,' Professor Haddon replying for the Royal Society and Mr. C. H. Read for the Society of Antiquaries and the Anthropological Institute. 'The Folk-lore Society' was proposed by Sir Richard Temple; the Chairman, Mr. Alfred Nutt, responding. During the evening Mrs. Kate Lee, Hon. Secretary of the Folk-song Society, sang some folk-songs which she had recently collected.

THE second of the receptions held annually by the Royal Society took place on June 21st.

The exhibits were, to a large extent, the same as those which were shown at the May *soirée*, and which we have already mentioned. Of additional exhibits the *Times* notes a series of Japanese paintings exhibited by Mr. W. Gowland which were an interesting novelty, showing as they do the different modes of depicting animal and plant life practiced by some of the great masters of the art of painting in Japan. So, too, were Sir Martin Conway's views in the Bolivian Andes, which were also exhibited during the evening on the screen by means of the lantern. Dr. Francisco Moreno showed a superb series of photographs and photographic panoramas illustrative of scenery in Patagonia. The models of the *Turbinia*, of a torpedo-boat destroyer and an Atlantic liner of 38,000 i. h. p. were of special interest. For more reasons than one Mrs. Ayrton's experiments on the hissing of the electric arc attracted considerable attention. Quite a novelty was Professor Haddon's collection of polished stone implements from the Baram district, Sarawak, Borneo. This is the first fruit, so far as public exhibition goes, of the important expedition to Torres Straits and Borneo, from which Professor Haddon has just returned. The Milne horizontal-pendulum seismograph, with specimens of the seismograms yielded by it, exhibited by the Seismological Committee of the British Association, was also new. It is a specimen of the earthquake records which are now being kept at a considerable number of stations established at widely-separated localities. In addition to the Andean views of Sir Martin Conway, Dr. Tempest Anderson exhibited, in the lecture-room, by means of the lantern, some very striking views of Vesuvius in eruption, and Mr. Herbert Jackson showed experiments displaying some new phenomena of phosphorescence.

IN the House of Commons Sir S. Montague recently called the attention of the President of the Board of Trade to a paragraph in the sixth report of Mr. T. Worthington on British trade in South America to the following effect: That the metric system is the only one recognized; that an English foot-rule cannot be legally imported, and that the trade of Great Britain suffers greatly by not adopting compulsorily the metric system used by almost all the the civilized nations of the world. He also referred to the Consular report on the trade of Amsterdam issued last month to the effect that, unless Great Britain adopted the metric system of weights and measures, it might look on the Continental and perhaps on other markets as lost to it; and asked whether Mr. Ritchie would facilitate the adoption of the metrical system in Great Britain by using metrical weights and measures in the government departments. Mr. Ritchie replied that there is now no reason why any manufacturer or trader in Great Britain may not carry on his foreign trade in terms of metric weights and measures. He stated that he was in communication with some government departments on the concluding paragraph of the question.

THE Volta centenary exhibiton at Como, to which we have already called attention, includes some interesting relics of Volta. These are contained, according to Mr. G. H. Bryan, (*Nature*) in one room in the exhibition buildings set apart for the 'Cimelii di Volta,' under which head are comprised Volta's physical apparatus, original manuscripts of his papers, his letters, diplomas and many of his personal effects. The greater part of these relics are exhibited by the Reale Istituto Lombardo, under whose auspices the collection was formed by public subscription in the years 1861 to 1864; for this collection one of the rooms belonging to the Society at Milan has been specially set apart. Other relics, chiefly personal, are exhibited by Professor Alessandro Volta and Professor Zanino Volta. The University of Pavia exhibits several electroscopes, condensers and similar electrostatic apparatus; and other exhibits are lent by the Como Museum. The manuscripts include the following: (1) A letter to Volta from the French physicist Nollet, dated September 18, 1767; (2) A letter from Volta to Professor Barletti, of Pavia, dated April 18, 1879, containing an anticipation of the electric telegraph. Volta suggests the possibility of connecting Milan and Como with a wire suspended from poles, so that an operator at one end of the line could fire an electric pistol at the other. (3) A manuscript dated May 14, 1782, dealing with animal electricity.

(4) Volta's paper of March 29, 1800, announcing his discovery of the electric pile to Sir Joseph Banks, President of the Royal Society. (5) Volta's monograph on the formation of hail, published about 1806. The apparatus exhibited illustrates Volta's inventions of the electrophorus and the 'electric pistol'; his application of gas to lamps, combined with an electric gas-lighting apparatus; his invention of the eudiometer; his researches on the capacity of condensers; his condensing electroscope; his investigations; on the law of electrostatic force involving the use of the electric balances and the electrometer; his researches on atmospheric electricity; his studies on the expansion of gases; his first forms of voltaic pile, including the columnar pile represented by several examples; also the 'crown of cups,' and his early experiments on electrolysis. A number of batteries of Leyden jars, electrostatic machines and other apparatus used by Volta in his experiments, while not referring to any special advancements in science, go far towards giving us an insight into the thoughts and pursuits of a physicist of a century ago of whom the people of Como feel justly proud.

ACCORDING to Reuter's agency the Governor of Algeria has received very favorable news regarding the Coppolani mission. After crossing the Niger bend and traversing the Arubruda the mission proceeded in a northeasterly direction as far as Baddab, receiving on the way the submission of several rebel tribes and entering into relations with the chief of the Awelimmiden. On returning to Timbuktu, M. Coppolani again set out with an escort composed of natives and Moors. This time he followed a northerly route. Telegrams received via Timbuktu during the last few days from him and his companion, Robert Aricand, state that they are the first two Frenchmen since René Caillie to explore that part of the country, and that they have reached Aruan, which serves as entrepot for the salt mines of Tauden. The journey through the country peopled by Moors was peacefully carried out and gave the best results.

THE Director of the Mint has issued the following figures regarding the production of gold in the United States during the year 1899:

	Gold	*Silver in fine ounces.*
Alabama	5,000	100
Alaska	2,525,800	92,400
Arizona	2,465,100	2,246,800
California	15,637,900	642,300
Colorado	23,195,300	22,815,600
Georgia	128,600	500
Idaho	1,716,900	5,073,800
Iowa	100	....
Maryland	600	....
Michigan	100	32,400
Minnesota	100	....
Montana	5,126,900	14,807,200
Nevada	2,994,500	805,000
New Mexico	539,000	425,000
North Carolina	84,000	700
Oregon	1,177,600	130,000
South Carolina	104,200	300
South Dakota	5,699,700	152,300
Tennessee	900	....
Texas	300	472,900
Utah	2,285,400	6,485,900
Virginia	4,500	...
Washington	766,200	254,400
Wyoming	5,300	100
Total	$64,463,000	54,438,000
Totals for 1897	57,363,000	53,860,000

THE annual general meeting of the Marine Biological Association was held, says *Nature*, in the rooms of the Royal Society on June 28th. The Council reported that the laboratory at Plymouth continued in a state of efficiency, and was adequately equipped with the most modern requirements for marine biological research. The investigation of the natural history of the mackerel, commenced last year by Mr. Garstang, had been continued, and a report on the variations, races and migrations of this fish had been published. A systematic study of the physical and biological conditions prevailing in the waters at the mouth of the English Channel had also been commenced, which it was hoped would throw light on the causes which determine the movements of migratory fishes. The examination of the fauna and bottom deposits between the Eddystone and Start Point had been concluded by Mr. Allen, the director of the laboratory. Seventeen naturalists and eleven students had worked in the laboratory, in addition to the members of the regular staff.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Lucy Ellis, of Boston, Harvard University is given real estate and made the residuary legatee. The money is to be used for the Medical School and is said to amount to more than $100,000.

THE decennial exercises of Clark University were concluded on July 10th with an address by President G. Stanley Hall and shorter addresses by Dr. W. H. P. Faunce, the newly elected President of Brown University, and Professor H. P. Bowditch, of Harvard University.

YALE University has bought, at an aggregate cost of $146,000, eight pieces of land on College Street, which it is reported will be used for the erection of an Alumni Hall. The purchase is important, because it joins the College campus with the Sheffield Scientific School.

THE Senate of the University of London, at their meeting on July 5th, passed, by 21 votes to 6, the following resolution, proposed by Sir Edward Fry and seconded by Mr. Bryce: "That the Senate accepts the proposal of her Majesty's government, as far as it provides in buildings of the Imperial Institute accommodation for the work hitherto done by the University; and authorizes the committee consisting of the Chancellor, Vice-Chancellor and Sir J. G. Fitch to settle the formal terms of agreement with the government, and the Senate reserves the right of the University to hereafter request the government to make further provision for such further needs as may arise in the future."

A SPECIAL conference is now being held in St. Petersburg of all the University rectors, the guardians of educational districts, and the chief inspector of all the technical schools of Russia, under the presidency of the Minister of Public Instruction, to consider what can be done to improve the situation as regards the students. The proceedings are strictly secret, but it is reported by the *Times* that they will probably result in some changes in the University statutes and regulations, giving the students more freedom. Most of the students who were in prison in St. Petersburg have been released, but they are apparently being sent out of the capital. There is no information as to what has been done with the arrested and banished students of other towns. It is felt that renewed trouble may be expected in the autumn and winter unless some radical improvement is made.

DR. GEORGE E. MACLEAN, Chancellor of the University of Nebraska since 1895, has accepted the presidency of the State University of Iowa, and assumes the duties of his new position on August 1st. The vacancy caused by his retirement from the University of Nebraska will be temporarily filled by Dr. Charles E. Bessey, who will be 'Acting Chancellor' until such time as the Regents elect a Chancellor.

DR. GEORGE T. WINSTON, President of the University of Texas, has sent in his resignation, to take effect September 15th next. Mr. Winston will assume the presidency of the North Carolina Agricultural and Mechanical College, at Raleigh, N. C., on October 1st. The election of a President of the University of Texas and of a successor to the late Dr. W. W. Norman, professor of animal biology, have been deferred until September.

SEVERAL changes have occurred in the mathematical department of the University of Texas. Dr. L. E. Dickson has been appointed associate professor. Dr. H. T. Benedict, of Vanderbilt University, and Mr. I. N. Putnam have been made instructors. Mr. Arthur Lefevre and Dr. M. B. Porter have resigned, the latter having been called to Yale University. In the same university Miss H. V. Whitten has been appointed tutor in geology, and Dr. James R. Bailey has been promoted to an adjunct professorship of chemistry.

THE *American Geologist* states that Curtis F. Marbut, assistant professor in the Missouri State University, has been promoted to the full professorship of geology in that institution and has been granted a year's leave of absence which he will spend in study and research abroad.

MR. J. LEWIS MCINTYRE, a graduate of Edinburgh and of Oxford, and at present lecturer in philosophy at Aberystwyth, succeeds Mr. Stout as lecturer in comparative psychology at Aberdeen.

SCIENCE

FRIDAY, JULY 28, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE NICARAGUA CANAL ROUTE.

THE attention which the problem of connecting the Atlantic and Pacific Oceans by means of a ship canal is now attracting lends an interest to any information concerning the Isthmian region and affords an excuse for the publication in SCIENCE of matter more fully published in other less widely circulated media.*

Exact information concerning the Nicaragua Canal Route is derived chiefly from four surveys of the region, made with a view to determining the best route for a ship canal. The first was made by Colonel Childs, in the interest of the Vanderbilt Transit Company, which held a concession from the Nicaraguan government for constructing a canal. The second was made by Commander Lull, under instructions from the Secretary of the Navy. These two surveys amounted to a good reconnaissance and served to show that no insurmountable obstacles were to be met with. The third survey was that made by the Maritime Canal Company, under the direction of Chief Engineer A. G. Menocal. This extended over several years, and was much more comprehensive than either of the

* Physiography and Geology of region adjacent to the Nicaragua Canal Route. *Bul. Geol. Soc. Am.*, vol. 10, pp. 285-348. 1899.

Physiography of the Nicaragua Canal Route. *Nat. Geog. Mag.*, July, 1899.

Appendix 2, report of the Nicaragua Canal Commission, 1897-99. Govt. Print. In press.

others. It resulted in the location of a route and the formation of final plans, on which construction was begun. Financial difficulties brought the work to a stop, and a proposition to transfer the concession and property of the Company to the United States brought the matter before Congress. In order to obtain information on which to base its action, Congress provided for the appointment of a commission to determine the feasibility and cost of the undertaking. This commission, of which Colonel Ludlow was president, made no actual surveys, but examined the route selected by the Canal Company, and its surveys, plans and estimates. As a result of this examination the commission doubled the estimates of cost made by the Company, and suggested material modifications in the plans adopted. It recommended that further investigation of the route be made before final action was taken by Congress. In accordance with this recommendation a new commission was authorized and appointed in 1897. This commission, of which Rear Admiral Walker was president, employed a large corps of engineers and carried on active field operations throughout the greater part of 1898. The work was conducted under the immediate supervision of Chief Engineer E. S. Wheeler, to whom the excellence of the results obtained is largely due.

This fourth survey of the canal region has been made on a somewhat more comprehensive plan than any of the others, and, while former work has been utilized, every important point has been carefully verified. Special attention has been paid to two subjects, hydrography and geology, concerning which, as pointed out by the Ludlow commission, the available information was extremely meager. Mr. A. P. Davis and the writer were detailed from the Geological Survey to conduct the investigations on these subjects.

Mr. Davis established a large number of stations, at which the streams were gauged and the rainfall and evaporation measured. The importance of his observations and deductions is shown by the material modifications they have necessitated in the Canal Company's plans.

The geologic work consisted in a systematic examination of the region adjacent to the canal route and in an examination of sub-surface conditions by means of the drill. Ample facilities were afforded for the latter, and a mass of exact information was obtained as a basis for estimates by the engineers. Owing to the great depth of rock decay in this region and the extensive accumulations of alluvium, estimates both for foundations and for excavations made without the data furnished by the drill are open to serious question.

Until the investigations of the Walker commission the information obtained by the various surveys was such as comes strictly within the purview of the engineer, and many facts having the most direct bearing upon the canal problem were entirely overlooked or ignored.

Notwithstanding the large amount of work done by eminent engineers in this portion of Central America, its physiographic features have never been adequately described. As late as the report of the Ludlow commission the conventional Humboldtian view of the topography prevails. According to this view, which should be definitely discarded at the outset, a continuous mountain chain connects the Cordilleran system of western North America with the Andean system of western South America. Hill has fully demonstrated the falsity of this old view and shown the complete independence of the orographic systems of the three Americas.

The most striking physiographic feature in this portion of Central America, and the one which has the most direct practical

bearing on the location of a canal route, is the great depression which extends diagonally across the isthmus, holding the Lakes Managua and Nicaragua and their outlet the San Juan River. Its southwestern margin is formed by the lofty volcanic range of northern Costa Rica, while it is less definitely limited on the northeast by the Chontales hills, which extend from the Caribbean coast westward to the lakes. The *Nicaraguan Depression*, as above outlined, is not a simple river valley, although it is now occupied by a single trunk stream and its tributaries. Except for the constructional volcanic slopes at its southern margin, the depression is due entirely to ordinary stream erosion. During its formation, however, the continental divide occupied a position near the axis of the isthmus, while the western coast was indented by a deep bay reaching to the center of the present basin of Lake Nicaragua. The relations of present to former divides and coast lines are shown on the accompanying map.

Considering a broad belt extending across the isthmus and embracing the Nicaraguan depression, three distinct types of topography are encountered, viz. :

Old-land areas with maturely developed degradational surfaces.

Recent flood-plains and deltas with still-forming aggradational surfaces.

Recent volcanic cones and plateaus with slightly modified constructional surfaces.

The old-land occupies much the larger portion of the region represented on the accompanying map. It forms the greater part of the Nicaraguan depression and expands northward between the divergent lines of the Caribbean coast and the Nicaragua-Managua lake basins. It also forms the narrower part of the land strip between lake Nicaragua and the Pacific. This old-land surface appears to have been above

sea level since the middle of the Tertiary, and its form is due entirely to the action of subaerial gradational forces. Although composed largely of volcanic rocks, the original constructional surfaces appear to have been entirely obliterated.

When examined in detail the old-land surface is found to have considerable diversity in its relief, and its topographic forms naturally fall into three classes. These are (1) fairly well developed and subsequently dissected peneplains whose remnants rise gradually from either coast toward the axis of the isthmus, which until recent geologic times was occupied by the continental divide; (2) residual hills or monadnocks which rise distinctly above the peneplain surface, being most numerous toward the axis of the isthmus along the former continental divide, and (3) many valleys which intersect the peneplain surface, having been cut during a period of high level and subsequently somewhat depressed.

The peneplain was most extensively developed near the east coast, but it has here suffered most from subsequent erosion, and only a few remnants occur along the lower portion of the San Juan Valley. Higher up the valley, at a distance of 40 or 50 miles from the Caribbean coast, the peneplain was well developed, and, although deeply dissected, the even summits of the hills, about 150 feet above sea level, and considerable areas of level country back from the river, give evidence of its former extent. To the west of the former divide a corresponding peneplain is found sloping gently westward. It forms a plain of variable width about the lower portion of Lake Nicaragua and doubtless extends beneath the waters of the lake.

As indicated above, the residual hills are most numerous near the position formerly occupied by the continental divide, being separated by low colls, in which opposing streams headed, slightly above the level of the peneplain. The San Juan Valley, where it crosses this monadnock belt, is very narrow and bordered by high hills with serrate outlines totally unlike the low even-topped hills on either side. The monadnocks increase in height and numbers toward the north, forming the Chontales hills, which merge with the mountains of northern Nicaragua. The latter reach altitudes of 5,000 to 7,000 feet.

The valleys which intersect the surface of the peneplain were cut when the land stood at least 200 feet higher than now. They have a much steeper gradient than the present streams, showing that the high-level period was not long enough for the streams to reduce their channels to base-level. A subsequent depression of the land drowned the lower portions of the valleys. On the Pacific side, where the coast is bold and rugged, these drowned valleys are comparatively narrow and filled with alluvium nearly or quite out to the rocky headlands, but the alluvium never extends seaward beyond the latter to form a delta. On the Caribbean side the rivers are longer and deliver more sediment than the waves and littoral currents can dispose of, and hence have not only filled the estuaries formed in the drowned valleys, but have built out a series of deltas which coalesce and form a coastal plain. The sediment brought down to the sea by streams north of the San Juan is small compared with that brought down by those to the south. The more rapidly growing southern deltas would, therefore, be extended seaward except for a strong northward sand current set up by the oblique direction at which the waves strike the shore. This sand current tends to distribute the sediment evenly along the coast and preserve gently curving coast lines. Sediment, however, is delivered by the San Juan slightly faster than it can be distributed. Hence it tends to build out a delta, but this is deflected to the northward and forms a curved sandspit which for a

time makes a sheltered harbor. As the sandspit continues to grow, its point eventually joins the mainland, and the harbor is converted into a closed lagoon. This complete cycle of changes has taken place at Greytown during the last century and a half, as shown by the early maps of that portion of the coast. The cycle has also been repeated at the same point several times previous to the one of which there is documentary evidence, giving rise to the several distinct lagoons which occur inland from the one last formed.

The surface of the San Juan delta-plain is diversified by occasional hills which were at one time islands fringing the coast, and also by numerous lakes and lagoons due to the uneven distribution of the sediment. At its inner margin it abuts against the foothills or merges with the broad flood-plain of the river.

The San Juan leaves the lake practically clear, and most of the sediment which it delivers at its mouth is received from two large southern tributaries, the San Carlos and the Sarapiqui. These have their source upon the slopes of the Costa Rican volcanoes, and bring down vast quantities of black volcanic sand. Below the mouth of the San Carlos the trunk stream carries more and coarser sediment than any of the smaller tributaries. It has, therefore, built up its flood-plain more rapidly than the tributaries, and the latter are dammed, forming extensive lagoons in the side valleys.

The recent volcanic activity in this region has given rise to two series of vents, having a very striking linear arrangement. The southern series extends diagonally across the isthmus, in northern Costa Rica, terminating near the Pacific in the extinct volcano Orosi. The materials extruded from these vents have built up the massive mountain range which forms the southern border of the Nicaraguan depression. The second series of vents extends northwestward from Madera, on an island in Lake Nicaragua, to Coseguina, on the Gulf of Fonseca. Between Madera and Orosi, the proximate ends of the two lines, is a gap of about 30 miles. The northern vents were at first submarine, extending in a line nearly parallel with the former coast. They have built up a broad, gently-sloping plateau, from which rise, singly and in groups, many symmetrical volcanic cones. Most of these vents are extinct, while a few have been in eruption since the Spanish conquest, but are now quiescent. The older cones have suffered considerable modification by erosion, while the newer ones, and also the plateaus, retain, in a large measure, their original constructional forms.

The rocks of the Nicaraguan depression are, so far as known, Tertiary and later. They include both sedimentary and igneous formations, though the latter greatly predominate. The strip of land between Lake Nicaragua and the Pacific, southward from a point opposite the Island Zapetero, is composed chiefly of sandstone and shales, with some beds of limestone, which Dr. Dall pronounces to be of Tertiary (Oligocene) age. The sandstones contain a large proportion of volcanic matter and might almost be classed as andesitic tuffs. Another area of similar rocks crosses the San Juan Valley between Castillo and the Boca San Carlos, and may originally have been continuous with the area west of the lake. With the exception of this small area of sandstone, the entire San Juan Valley is composed of igneous rocks, including lavas, tuffs, breccias and conglomerates. These are all, so far as known, of Tertiary age. The lavas are chiefly basalts, andesites and dacite. The recent volcanic rocks are chiefly andesites, with a few lava flows of basalt.

The climatic conditions prevailing in this region have a very direct connection with its physiography and form one of the most

important factors in the canal problem. Through the greater part of the year the trade winds prevail with fairly constant direction and force. They are deflected slightly to the north by the high volcanic range of Costa Rica and to the south by the mountains of northern Nicaragua. The low gap across the isthmus constituting the Nicaraguan depression thus receives more wind than would be due to the normal trades, and it is probably this congestion of the air currents that causes the exceptional precipitation of this region. Within the zone of maximum precipitation which embraces the coastal plain and adjacent hills, forming a belt from 50 to 75 miles broad, the annual rainfall reaches nearly 300 inches. Beyond this belt, with increasing distance from the Caribbean coast, it decreases very rapidly, and in the western portion of the region the average annual rainfall is less than a third and in some seasons less than a tenth of that on the eastern coast. More important, however, than the absolute amount of rain is its distribution throughout the year. In the eastern division the rain is distributed with tolerable uniformity through the year. In the western division, on the other hand, there is a distinct dry season of five or six months. These climatic differences give rise directly to very striking differences in vegetation and, either directly or indirectly, to differences in the appearance and structure of the soils, in the topographic forms of the land surface and in the effectiveness of various physiographic processes.

The eastern division is covered by a dense tropical forest wherever the land is sufficiently firm to support large trees. The falling rain is intercepted by the canopy of foliage and filters gradually down to the surface, where the smaller vegetation affords a further protection, so that the soil never receives the direct impact of the rain drops. The abundant forest litter decays rapidly, furnishing a constant supply of the complex organic acids which are chiefly instrumental in promoting rock decay, and the latter process is extremely active. Solid rock is rarely found, except in residual bowlders, at depths less than 40 to 100 feet from the surface. The prevailing soil is a very tenacious, residual, red clay which never becomes dry enough to be intersected by shrinkage cracks and which, although to some extent loosened by roots and insects, resists erosion to a remarkable degree. After a careful study of the region it was concluded that the absence of frost and the presence of the tropical forest more than counterbalance the enormous rainfall and that surface degradation is, on the whole, slower than in most temperate regions.

The western division, particularly that portion lying between the lakes and the Pacific, is characterized by open savannahs and the thin foliaged, thorny forests of a semi-arid region. The forest litter is mostly destroyed by fires during the dry season, so that rock decay is hindered and the soil is wholly unprotected from the torrential rainfall which inaugurates the wet season. The soil, which is never red, but generally dark blue, is alternately intersected by shrinkage cracks and saturated with water, a process which serves to loosen it almost as effectually as frost. It results that the streams, which are alternately rivulets and torrents, bear great quantities of detritus, and the surface degradation is comparatively rapid.

No sedimentary or other records have been found in this portion of Central America which carry its history back to an earlier period than the Tertiary. During the Oligocene there was probably free communication between the waters of the Atlantic and Pacific, the region of the Nicaraguan depression being occupied by a shallow sea in the vicinity of which were many active volcanoes. The extrusion of volcanic materials and the deposition of sediments

continued until late Tertiary time, when the region was elevated, a land barrier cutting off connection between the two oceans, which has never been restored. After a long period of quiesence, during which extensive peneplains were developed on both sides of the continental divide then occupying the axis of the isthmus, the region suffered another elevation and the peneplains were deeply trenched by river valleys. This period of gorge cutting was followed by a subsidence equal to about half the previous uplift. The river valleys were drowned, and the estuaries thus formed have since been in part or entirely silted up.

The renewal of volcanic activity in late Tertiary or post-Tertiary time gave rise to the two mountain ranges above described. The position of the northern series of vents with reference to the coast line was such that when their ejected material had reached the surface of the sea it formed a barrier across the bay which then indented the Pacific coast. This barrier was built gradually higher by successive eruptions, and since in the area behind it precipitation was greater than evaporation the waters rose above sea level and doubtless escaped westward over the barrier during periods of quiesence in the volcanic activity. As the surface of the barrier was raised by the addition of volcanic ejecta, the surface of the impounded waters was raised to a height probably somewhat above the present elevation of Lake Nicaragua. The lake thus formed occupied not only the position of the former bay, but flooded the basins of the tributary streams and was considerably larger than the present Lakes Managua and Nicaragua combined. Its surface finally reached a low point in the continental divide where a west-flowing stream headed against one which occupied the present position of the San Juan. When this point was reached the intermittent escape of the impounded waters across the volcanic dam to the westward was changed for a permanent outlet to the eastward.

The gap when first discovered and overtopped by the rising waters was doubtless in deeply weathered rock and residual clay. It must, therefore, have been cut down very rapidly until the underlying hard rock was reached, when the permanent level of the lake was established which it has retained practically unchanged to the present time. It is quite possible that the gaps through the continental divide to the east and through the divide between the lake and ocean to the west were so near the same level that the impounded waters had for a short time an outlet both to the Atlantic and to the Pacific. The upper Rio Grande is flowing in a partly silted-up rock gorge much too large for the present stream, and it appears probable that this gorge was cut by the outflow from the lake before it was entirely and permanently diverted to the eastward outlet.

Certain features which have a specially direct bearing upon the canal problem should receive a further word of description. One of these is the gap followed by the canal route between the lake and the Pacific, the lowest gap in the continental divide between the Arctic Ocean and the Straits of Magellan.

The lower portion of the lake is bordered by the peneplain above described which, in the vicinity of Rivas, is very perfectly baseleveled. The plain rises gradually westward from the lake shore to the range of hills which forms the divide. These hills are from 500 to 1,200 feet high and extend northward to a point opposite the Island Zapetero where they meet the Jinotepe plateau and their residual old-land forms give place to the even constructional slopes of the latter. A single break occurs in this continuous line of hills, forming the gap between the waters of the Rio Lajas and the Rio

Grande, and whose summit is only 50 feet above the lake and 154 feet above sea level. This gap, which occupies so important a relation to the proposed canal, is the product of the familiar process of stream capture. Owing to the decided advantages possessed by the streams flowing directly to the Pacific over those flowing eastward, at first to the bay indenting the Pacific coast and afterwards to the lake, the former were able to cut backward through the divide into the drainage area of the latter and to divert their headwaters. In this way an eastward-flowing stream originally occupying the position of the Tola, the upper Rio Grande, the Guiscoyol and the Lajas was beheaded and the drainage of a large part of its basin was diverted to the Pacific. The deserted valley of this stream forms the low gap through which the canal route is located. It is so broad and level that accurate instrumental work is required to determine the actual summit of the continental divide.

Considering the origin of Lake Nicaragua, it is manifest that it must originally have extended entirely down to the point where its waters escaped through the gap in the continental divide—that is, to the present Castillo Rapids. This point, however, is now more than 30 miles down the San Juan River from the lake. The upper portion of that river meanders through an alluvial plain which becomes narrower down streams and has evidently been reclaimed from the waters of the lake by sedimentation. It is well recognized that lakes are ephemeral features, and the commonest way in which they are obliterated is by the filling at their upper ends with sediment deposited at the mouths of tributaries. In this case, however, the process is reversed. The area of the lake is being contracted chiefly by filling at its lower end. The filling is being accomplished by the tributaries entering this lower portion of the lake, many of which have been converted into tributaries of the San Juan. The present river channel does not coincide with the position of the river which formerly occupied this basin before it was drowned by the waters of the lake. Its position is dependent on the relative amounts of sediment delivered by the tributaries on either side, and it has been pushed toward the northern side of the old basin by the larger tributaries from the south, the Frio and Poco Sol. This portion of the San Juan may best be described as a *residual river channel*—that is, a broad arm of the lake has been gradually constricted by the deposition of sediment on its margin, and all that remains is the narrow river channel kept open by the current of water flowing from the lake. This hypothesis, verified by borings made in the river channel, has been of material service in so locating the canal line that all rock excavation in this portion between the lake and the Castillo Rapids should be avoided.

While the writer has no intention of touching upon the engineering features of the canal problem, it may be stated that the geologic examination of the route, including the boring, has resulted, in nearly every case, in showing that conditions are more favorable than they had previously been assumed. In the few cases in which less favorable conditions were found modifications in the plans suggested themselves by which the unfavorable conditions are avoided.

Thus the project, which has repeatedly been pronounced feasible by eminent engineers, is placed in a still stronger position by the most exacting scientific tests.

C. WILLARD HAYES.

U. S. GEOLOGICAL SURVEY, July, 1899.

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*TRANSPARENCY AND OPACITY.**

ONE kind of opacity is due to absorption; but the lecture dealt rather with that de-

* Abstract of a lecture given by Lord Rayleigh before the Royal Institution of Great Britain.

ficiency of transparency which depends upon irregular reflexions and refractions. One of the best examples is that met with in Christiansen's experiment. Powdered glass, all from one piece and free from dirt, is placed in a bottle with parallel flat sides. In this state it is quite opaque; but if the interstices between the fragments are filled up with a liquid mixture of bisulphide of of carbon and benzole, carefully adjusted so as to be of equal refractivity with the glass, the mass becomes optically homogeneous, and therefore transparent. In consequence, however, of the different dispersive powers of the two substances, the adjustment is good for one part only of the spectrum, other parts being scattered in transmission much as if no liquid were employed, though, of course, in a less degree. The consequence is that a small source of light, backed preferably by a dark ground, is seen in its natural outlines, but strongly colored. The color depends upon the precise composition of the liquid, and further varies with the temperature, a few degrees of warmth sufficing to cause a transition from red through yellow to green.

The lecturer had long been aware that the light regularly transmitted through a stratum of 15 to 20 mm. thick was of a high degree of purity, but it was only recently that he found, to his astonishment, as the result of a more particular observation, that the range of refrangibility included was but two and a half times that embraced by the two D-lines. The poverty of general effect, when the darkness of the background is not attended to, was thus explained; for the highly monochromatic and accordingly attenuated light from the special source is then overlaid by diffused light of other colors.

More precise determinations of the range of light transmitted were subsequently effected with thinner strata of glass powder contained in cells formed of parallel glass. The cell may be placed between the prisms of the spectroscope and the object glass of the collimator. With the above-mentioned liquids a stratum 5 mm. thick transmitted, without appreciable disturbance, a range of the spectrum measured by 11.3 times the interval of the D's. In another cell of the same thickness an effort was made to reduce the difference of dispersive powers. To this end the powder was of plate glass and the liquid oil of cedar-wood adjusted with a little bisulphide of carbon. The general transparency of this cell was the highest yet observed. When it was tested upon the spectrum the range of refrangibility transmitted was estimated at 34 times the interval of the D's.

As regards the substitution of other transparent solid material for glass the choice is restricted by the presumed necessity of avoiding appreciable double refraction. Common salt is singly refracting, but attempts to use it were not successful. Opaque patches always interfered. With the idea that these might be due to included mother liquor, the salt was heated to incipient redness, but with little advantage. Transparent rock-salt artificially broken may, however, be used with good effect, but there is some difficulty in preventing the approximately rectangular fragments from arranging themselves too closely.

The principle of evanescent refraction may also be applied to the spectroscope. Some twenty years ago an instrument had been constructed upon this plan. Twelve 90° prisms of Chance's 'dense flint' were cemented in a row upon a strip of glass, and the whole was immersed in a liquid mixture of bisulphide of carbon with a little benzole. The dispersive power of the liquid exceeds that of the solid, and the difference amounts to about three-quarters of the dispersive power of Chance's 'extra dense flint.' The resolving power of the latter glass is measured by the number of centi-

meters of available thickness, if we take the power required to resolve the D-lines as unity. The compound spectroscope had an available thickness of 12 inches or 30 cm., so that its theoretical resolving power (in the yellow region of the spectrum) would be about 22. With the aid of a reflector the prism could be used twice over, and then the resolving power is doubled.

One of the objections to a stereoscope depending upon bisulphide of carbon is the sensitiveness to temperature. In the ordinary arrangement of prisms the refracting edges are vertical. If, as often happens, the upper part of a fluid prism is warmer than the lower the definition is ruined, one degree (Centigrade) of temperature making nine times as great a difference of refraction as a passage from D_1 to D_2. The objection is to a great extent obviated by so mounting the compound prism that the refracting edges are *horizontal*, which, of course, entails a horizontal slit. The disturbance due to a stratified temperature is then largely compensated by a change of focus.

In the instrument above described, the dispersive power is great—the D-lines are seen widely separated with the naked eye—but the aperture is inconveniently small ($\frac{1}{2}$-inch). In the new instrument exhibited, the prisms (supplied by Messrs. Watson) are larger, so that a line of ten prisms occupies 20 inches. Thus, while the resolving power is much greater, the dispersion is less than before.

In the course of the lecture the instrument was applied to show the duplicity of the reversed soda lines. The interval on the screen between the centers of the dark lines was about half an inch.

It is instructive to compare the action of the glass powder with that of the spectroscope. In the latter the disposition of the prisms is regular, and in passing from one edge of the beam to the other there is complete substitution of liquid for glass over the whole length. For one kind of light there is no relative retardation, and the resolving power depends upon the question of what change of wave-length is required in order that its relative retardation may be altered from zero to the quarter wave-length. All kinds of light for which the relative retardation is less than this remain mixed. In the case of the powder we have similar questions to consider. For one kind of light the medium is optically homogeneous, *i. e.*, the retardation is the same along all rays. If we now suppose the quality of the light slightly varied, the retardation is no longer precisely the same along all rays; but if the variation from the mean falls short of the quarter wave-length it is without importance, and the medium still behaves practically as if it were homogeneous. The difference between the action of the powder and that of the regular prisms in the spectroscope depends upon this, that in the latter there is complete substitution of glass for liquid along the extreme rays, while in the former the paths of all the rays lie partly through glass and partly through liquid in nearly the same proportions. The difference of retardations along various rays is thus a question of a deviation from an average.

It is true that we may imagine a relative distribution of glass and liquid that would more nearly assimilate the two cases. If, for example, the glass consisted of equal spheres resting against one another in cubic order some rays might pass entirely through glass and others entirely through liquid, and then the quarter wave-length of relative retardation would enter at the same total thickness in both cases. But such an arrangement would be highly unstable, and if the spheres be packed in close order the extreme relative retardation would be much less. The latter arrangement, for which exact results could readily be calculated, represents the glass powder more nearly than does the cubic order.

A simplified problem in which the element of chance is retained may be constructed by supposing the particles of glass replaced by thin parallel discs which are distributed entirely at random over a certain stratum. We may go further and imagine the discs limited to a particular plane. Each disc is supposed to exercise a minute retarding influence on the light which traverses it, and they are supposed to be so numerous that it is improbable that a ray can pass the plane without encountering a large number. A certain number (m) of encounters is more probable than any other, but if every ray encountered the same number of discs the retardation would be uniform and lead to no disturbance.

It is a question of probabilities to determine the chance of a prescribed number of encounters, or of a prescribed deviation from the mean. In the notation of the integral calculus the chance of the deviation from m lying between $\pm r$ is *

$$\frac{2}{\sqrt{\pi}}\int_0^{\tau} e^{-\tau^2}\, d\tau,$$

where $\tau = r / \sqrt{(2m)}$. This is equal to ·84 when $\tau = 1·0$, or $r = \sqrt{(2m)}$; so that the chance is comparatively small of a deviation from m exceeding $\pm \sqrt{(2m)}$.

To represent the glass powder occupying a stratum of 2 cm. thick we may perhaps suppose that $m = 72$. There would thus be a moderate chance of a difference of retardations equal to, say, one-fifth of the extreme difference corresponding to a substitution of glass for liquid throughout the whole thickness. The range of wave-lengths in the light regularly transmitted by the powder would thus be about five times the range of wave-lengths still unseparated in a spectroscope of equal (2 cm.) thickness. Of course, no calculation of this kind can give more than a rough idea of the action of the powder, whose disposition, though partly a matter of chance, is also influenced by mechanical considerations; but it appears, at any rate, that the character of the light regularly transmitted by the powder is such as may reasonably be explained.

* See *Phil. Mag.* 1899, Vol. XLVII., p. 251.

As regards the size of the grains of glass it will be seen that as great or a greater degree of purity may be obtained in a given thickness from coarse grains as from fine ones, but the light not regularly transmited is dispersed through smaller angles. Here, again, the comparison with the regularly disposed prisms of an actual spectroscope is useful.

At the close of the lecture the failure of transparency, which arises from the presence of particles, small compared to the wave-length of light was discussed. The tints of the setting sun were illustrated by passing the light from the electric lamp through a liquid in which a precipitate of sulphur was slowly forming.* The lecturer gave reasons for his opinion that the blue of the sky is not wholly, or even principally, due to particles of foreign matter. The molecules of air themselves are competent to disperse a light not greatly inferior in brightness to that which we receive from the sky.

R.

DISTRIBUTION OF THE KEEWATIN IN MINNESOTA.

IN Minnesota the lithological characters of that part of the Algonkian known as Lower Huronian or Keewatin are necessary in the recognition of the stratigraphic subdivisions of geographically separated localities. The Keewatin carries the first clearly defined sediments of this portion of the globe. Often the clastic origin of the rocks has been so completely obliterated by alteration due largely to dynamic metamorphism that it is difficult to distinguish them from their associates. At the bottom of the series is usually a quartzite which is locally con-

* Op. cit., 1881, Vol. XII., 96.

glomeratic and not infrequently a quartz— to mica-schist in petrographic habit.

The following are the localities of accepted Keewatin: 1. Lake of the Woods district. Four ridges corresponding to as many upward folds of the Archean contain in the troughs between them the softer mica-schists, chlorite-schists, agglomerates, etc., of the Keewatin. [Compare Lawson, Geol. and Nat. Hist. Sur. Can. 1885, cc., pp. 10–22.] On the Minnesota side of the lake there is less opportunity for study; it is probable that not all three intervening depressions will be found south of the international boundary. 2. Along Rainy River and in the Rainy Lake region a double trough formed by the earlier rocks contains the Lower Huronian series. While the rocks consist largely of volcanics now altered to hornblende—and hornblendic schists, there are also fissile glossy schists, carrying water-worn pebbles, breccias, graywackes, etc. The Lower Huronian rock exposures of the northern Rainy Lake basin can be traced in direct continuity into the rocks in the Lake of the Woods district already noted. [Lawson, Amer. Jour. Sci. 1887, vol. 133, pp. 477, 478.] In 1894 H. V. Winchell and U. S. Grant carefully mapped this region and described a belt of Keewatin "conglomerates, slates, sericitic, chloritic and hornblendic schists, agglomerates, graywackes and more or less altered igneous rocks, both acid and basic." The most important belt enters Minnesota between Rainy Lake City and the north shore of Jackfish Bay. The general direction of this belt is W. 15°–20° S., according to the map referred to, the greater part of the area in view lying within Ontario. Many of the gold locations around Rainy Lake lie in the Keewatin rock areas. [Prelim. Rep. on Rainy L. gold region 23d Ann. Rep. Geol. and Nat. Hist. Sur. Minn., 1895, pp. 36–104.] 3. The most eastern of the successive belts of Keewatin rocks extending from Ontario into Minnesota is that in exposure along the boundary between the head of Basswood Lake and Lake Saganaga, with Knife Lake as a sort of axis. This belt, followed in a W., S. W. direction, becomes effectually covered by glacial drift a short distance beyond Vermilion Lake. Two or three exposures are reported from near the Mississippi River. The rocks are conglomerates, sericitic schists, more or less altered eruptives and the remarkable segregations of hematite mined between Tower and Ely and occurring in what have thus far proved leaner deposits eastward, possibly into the Kaministiquia district of Ontario. Economically this is the most important Keewatin area in Minnesota thus far explored.

In the eastern and central portions of the State are rocks hitherto not generally regarded as Keewatin: 4. Several areas may be grouped: (*a*) At Thomson, Carlton and southwestward lies an extensive mass of quartzose clastics in which occur lenses or beds of slate regarded by Irving and N. H. Winchell as Animiké; locally they are conglomeratic. (*b*) Around Barnum and Moose Lake lies a series of hornblende-biotite schists dipping at a low angle southward; the texture is rather fine and the general aspect of the rocks fresh and sharply crystalline. (*c*) West of Sturgeon Lake lies a belt of hornblende schists dipping at a high angle or standing vertical with interleaved granitic, gneissic and quartzose masses. These schists are, in places, garnetiferous and frequently abound in lenses and stringers of quartz. (*d*) Still farther southwestward, on the Kettle River, are exposures of mica schists with veins and dikes of granite within the schists, while (*e*) at Ann River and westward through Mille Lacs, Benton, Sherburne and Stearns counties are enormous masses of hornblende-biotite granite. These granites in their freshest condition carry augite cores within

the hornblende-biotite areas and in several localities are in apparent proximity to gabbro. (*f*) Farther north, on the Mississippi River, from Two Rivers past Little Falls to the valley of the Elk River, are extensive exposures of a fine-grained hornblende-biotite schist carrying bosses of gabbro and lenses of quartz-diorite [J. H. Kloos, Neu. Jahrb. für. Min., 1877, S. 225] and, also locally, thickly studded with staurolite crystals and garnets. (*g*) Finally the interesting masses of epidote granite and associated basic eruptives of Western Stearns, Todd and Cass counties.

I have reached the conclusion that all the areas enumerated under (*a*) to (*g*) above belong to the same geologic time division, viz., the Keewatin. The clastics, partially altered clastics and thoroughly crystalline schists in the areas (*a*), (*b*), (*c*), (*d*) and (*f*) belong to a single rock series and the granites and gabbros of areas (*d*), (*e*), (*f*) and (*g*) are eruptive through them. The staurolite, garnet, quartz-lenses, etc., essentially contact minerals, bear circumstantial evidence of the proximity of eruptive masses of granite or gabbro even where such masses are not now seen owing to enormous subsequent erosion or the covering of glacial drift.

Among the considerations upon which the foregoing conclusion was reached are the following: 1. The quartzose clastics and hornblende-biotite schists, which are admittedly one and the same rock series [Irving, R. D., Fifth An. Rep. Director U. S. Geol. Sur., p. 196], can be traced by petrographic and structural characters through Mahtowa, Barnum and Moose Lake in an almost continuous succession of exposures from the Thomson conglomerate to the coarser garnetiferous schists, carrying quartz stringers and lenses in considerable profusion west of Sturgeon Lake; and these in turn through reported exposures [Hopewell Clarke, Land Commissioner, St. Paul and Duluth R. R.] to the Snake River valley schists filled with dikes of granite. 2. The relation of the Snake River granite dikes in T. 42, R. 23 W., and the granites of Kanabec, Mille Lacs, Benton, Sherburne and Stearns counties cannot be traced in the field, yet their petrographic characters are essentially alike, and they have always been assumed to be the same. 3. The staurolite-bearing southern border of the Mississippi Valley schists disappears beneath the glacial drift in striking nearness to the granites of Stearns and Morrison counties. 4. Nowhere in Minnesota has this type of granite been found intrusive into or through the Animiké [for illustration compare Irving, R. D., Seventh An. Rep. Director U. S. Geol. Sur., pp. 421, 422]; in several places in central North America it is reported as penetrating and lying upon the Keewatin [*e. g.*, Lawson, A. C., Geol. and Nat. Hist. Sur. Can., 1885, cc., p. 14].

Summarizing: The Keewatin of Minnesota, therefore, occupies a much greater area than has hitherto been assigned to it, since it underlies the large central region of the State. It here consists of two distinct rock groups, one a clastic-crystalline and the other an eruptive, partly acid and partly basic, breaking into and through the former. The two exhibit in places a typical eruptive unconformity, yet volcanic activity apparently ceased before overlying rocks were laid down upon the intermingled eruptive and clastic material.

The hornblende-biotite granites of central Minnesota constitute enormous erupted masses, probably laccolitic in structure, which towards the northeast give place to a system of dikes which break through the schists and cause the greatest stratigraphic confusion. It is in this region that the schists become thickly studded with contact minerals.

The succession of characters representing

the transition of a clastic rock into a schist, and the loading of the schist with accessory minerals in the vicinity of the intruding eruptives, is identical with what can be seen in the Black Hills, and described for the same region by Van Hise [Bull. Geol. Soc. Am., Vol. I., pp. 209–211]. The metasomatic changes of the quartz clastics to crystalline schists in Minnesota is a process identical with what has been so fully discussed for the Penokee Range of Wisconsin [Van Hise, Amer. Jour. Sci., Vol. 131, pp. 453–459] and recognized in other localities too numerous to cite.

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THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

THE thirteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at San Francisco, July 5th–7th, in conjunction with the Association of Official Agricultural Chemists. Delegates from 34 States and Territories were in attendance. The welcome of the city was voiced by Mayor Phelan, and many courtesies were extended the visitors by individuals and associations representing the State of California. Especial mention should be made of the untiring efforts of Professor M. E. Jaffa, of the University of California, to facilitate the business of the convention and secure the personal comfort of the delegates.

Dr. H. P. Armsby, director of the experiment station connected with the Pennsylvania State College, presided at the general sessions and delivered the President's annual address. This was a clear and forcible presentation of the central purpose of the experiment stations as institutions of higher education. By original research they are to increase our knowledge of the principles underlying the art of agriculture and show the farmer how these may be applied to the advantage of his practice. The station should be the source of knowledge and inspiration for the agricultural college—the cap-stone of agricultural education. As such it should be divorced as far as possible from the routine elementary instruction of the college. At its head should be a director who inspires rather than directs.

By appointment President M. H. Buckham, of the University of Vermont, pronounced a graceful and discriminating eulogy on Senator Justin S. Morrill and introduced memorial resolutions which were unanimously adopted. In discussing Senator Morrill's relation to the great educational measures with which his name will always be connected, President Buckham said that the central idea which the great statesman intended to embody in this legislation was that it was possible by a suitable form of higher education to lift the arts and industries to the plane hitherto occupied alone by the professions. This the speaker claimed was a unique American idea, and its practical crystallization in the Morrill Acts of 1862 and 1890 placed them among the epoch-making acts of the American Congress.

The fourth report of progress of the Committee on Methods of Teaching Agriculture was read by Director A. C. True, secretary of the committee. This report presented a syllabus of a course in zootechny which was limited to the theory and practice of the production of the normal useful animal. Zootechny was divided by the committee into three main branches: (1) types and breeds of useful animals; (2) feeding, and (3) hygiene and management. It was deemed most feasible that the teaching of the general principles under each one of these heads should be immediately followed by the application of the principles to practice as regards different kinds of ani-

mals. The committee, however, conceded that there were important pedagogical reasons favoring the teaching of the principles of zootechny as a whole before proceeding to discuss their practical application to the art of animal husbandry. Explanation was also made of the general considerations which had governed the committee in constructing its syllabi for both agronomy and zootechny. An interesting discussion followed this report, in which some of the difficulties in separating instruction in technical agriculture from that in agricultural chemistry, economic botany, soil physics and other related sciences were pointed out. The committee was continued, and hopes during the next year to complete its outline of the college course in agriculture, by making syllabi for the courses in agrotechny, rural engineering and rural economics.

The absorbing interest which the Association takes in questions relating to the improvement of courses and instruction in agriculture and mechanic arts was further shown by the relatively large number of papers on these subjects read and discussed at this meeting. Such were the papers on the principles which should underlie the formation of a course in agriculture, by Dr. C. E. Coates, Jr., of Louisiana; the short dairy course, by Professor W. J. Spillman, of Washington; horticultural education in Minnesota, by Director W. M. Liggett, of Minnesota; university extension in agriculture, by President J. H. Raymond, of West Virginia; the teaching of machine design, by J. T. Faig, of Kentucky; the agricultural engineer—the latest developed specialist, by W. T. Magruder, of Ohio; some objections to early differentiation of engineering courses by J. C. Nagle, of Texas; and teaching methods in the mechanic arts, by H. Gwinner, of Maryland.

The most largely attended section was that on Agriculture and Chemistry. This was due in large measure to the program, which included subjects of vital importance to the West. These in general related to alkali soils, irrigation, and the range feeding of cattle. In the absence of Professor Hilgard, Professor R. H. Loughridge, of California, discussed the alkali soils of the Pacific coast and their utilization, showing the nature of 'white' and 'black' alkali and the means adopted by the California Station for the reclamation of alkali lands. The problems related to similar lands in New Mexico, Montana and Wyoming were respectively described by Professors A. Goss, F. W. Traphagen and B. C. Buffum. Some interesting work of the Wyoming Station relating to the effects of alkali on the germination of seeds was described by Professor Buffum. Irrigation problems in the West were outlined by Professor L. G. Carpenter, of Colorado, who illustrated his remarks with interesting charts showing the economy and waste in the use of irrigation water in practice on different farms. The work in irrigation lately undertaken by the Department of Agriculture was explained by Director True and Professor Elwood Mead, the irrigation expert in charge of these investigations. Professor E. J. Wickson, of California, told some of the facts learned from practice in the use of irrigation for orchard fruits. He urged that irrigation showed beneficial results not only in the increased vigor and productiveness of the trees, but in the improved appearance and quality of the fruit.

On the range feeding of cattle papers were presented by Professors W. W. Cooke, of Colorado; C. D. Smith, of Michigan, and H. T. French, of Idaho. The latter contended that his experience indicated that range steers could be conveniently and profitably fattened for market by stall feeding following that on the range. Mr. V. K. Chesnut, of the Division of Botany, Department of Agriculture, aroused consider-

able interest by his paper on plants poisonous to stock, a subject which is receiving attention at several of the Western stations.

In the section on Horticulture and Botany Mr. Alexander Cran, quarantine officer of the California State Board of Horticulture, read a paper on the inspection of nursery stock and orchards, which was followed by considerable discussion of the methods used in this work. Professor A. J. McClatchie, of Arizona, described the methods of irrigation used in orchards. Papers on 'Seed Testing,' by A. J. Pieters, of the Division of Botany, Department of Agriculture, and the 'Climatology of Horticulture,' by Professor E. J. Wickson, were read before the general session of the Association on the recommendation of the section. The latter was a suggestive paper expressing a hope that the relation of climate to the production of horticultural plants might ere long receive serious attention in this country.

The increasing importance of cooperation between the Department of Agriculture and the experiment stations attracted the attention of the Association, and a committee was appointed to consider the basis and methods of such cooperation and report at the next meeting.

The Executive Committee was instructed to endeavor to secure some arrangement by which public documents might be more promptly and satisfactorily delivered to the libraries of the institutions entitled to receive them, and also to obtain a place on the program of the next meeting of the National Education Association for a paper on the mission of the land-grant colleges in our American system of education.

Much interest was manifested in the announcement of the arrangement recently made by the Secretary of Agriculture with the Civil Service Commission under which it is proposed to admit a limited number of the graduates of the land-grant colleges to the Department of Agriculture at a nominal salary as 'scientific aids.' Vacancies in the Committee on Graduate Study at Washington were filled, and it is expected that this committee will continue to promote the plans of the Association for the establishment of a bureau of graduate study at the National capital.

The following officers of the Association for the ensuing year were elected:

President, J. E. Stubbs, of the University of Nevada; Vice-Presidents, E. W. Hilgard, of the University of California; J. M. Stone, of the Agricultural College of Mississippi; E. E. Smiley, of the University of Wyoming; M. H. Buckham, of the University of Vermont, and M. A. Scovell, of the Experiment Station of Kentucky; Secretary-Treasurer, E. B. Voorhees, of the Experiment Station of New Jersey; Bibliographer, A. C. True, of the Department of Agriculture. Executive Committee, H. H. Goodell, of the Massachusetts Agricultural College; W. M. Liggett, of the Universiity of Minnesota; J. H. Washburn, of the Agricultural and Mechanical College of Rhode Island, and Alexis Cope, of the University of Ohio.

Officers of Sections: College Work—J. K. Patterson, of Kentucky, Chairman; A. W. Harris, of Maine, Secretary. Agriculture and Chemistry—L. G. Carpenter, of Colorado, Chairman; C. D. Woods, of Maine, Secretary. Horticulture and Botany—L. A. Beach, of New York, Chairman; P. H. Rolfs, of South Carolina, Secretary. Mechanic Arts—C. S. Markland, of New Hampshire, Chairman; F. P. Anderson, of Kentucky, Secretary.

The day succeeding the adjournment of the convention was spent in visiting the University of California, and the following week was occupied in excursions to the principal agricultural and horticultural sections of central California. These excur-

sions, freely provided for the entertainment of the two Associations by the railroads and citizens of California, were much appreciated by the delegates, who were thus enabled to learn many important things regarding the wonderful natural resources and industrial development of California, which the ordinary tourist does not become acquainted with.

A. C. TRUE.

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*INTERNATIONAL CONFERENCE ON HYBRIDIZATION.**

AT the Royal Horticultural Society's gardens at Chiswick, on July 11th, an International Conference was opened for the purpose of discussing 'Hybridization and the Cross-breeding of Varieties.' There were present representatives of the government of the United States and of most of the European countries, besides a large number of British hybridists and botanists. An interesting and unique exhibition of plants and flowers had been arranged in the vinery. All the exhibits were received under condition that they were 'a new species or new variety.' Most of the plants bore a card which stated the name of the hybrid or cross-bred, the name of the female or seed parent, the name of the male or pollen parent, and remarks on variation, size, form and color. Sir Trevor Lawrence, the President of the Royal Horticultural Society, welcomed the members of the Conference, and mentioned that the King of the Belgians had conferred upon Dr. Maxwell Masters, F.R.S., who later on took the chair at the Conference, the insignia of an officer of the Order of Leopold.

At the sitting of the Conference Dr. Maxwell Masters, in opening the proceedings, gave an address on the history of hybridization. He said they had met to discuss the most important problem of modern progress in experimental horticulture. Apart from scientific experimental horticulture he did not think that they had progressed at all, as far as the practical details of cultivation were concerned, beyond what their forefathers had done. But when they came to scientific experimental work their forefathers were nowhere. If they went into present-day gardens they found that nine-tenths of the plants were the productions of the gardener's art, and not natural productions. There was a time when they took an interest in new plants introduced from the tropics and elsewhere; but now the Horticultural Society's flower shows at the Drill-hall, Westminster, did not produce anything new more than once or twice in a year. The so-called new plants now exhibited were the products of the gardener's art. Referring to the discussions in the early part of the 18th century as to the question of sexes in plants, he said that the first person in this country or any other who formed an artificial hybrid purposely—many people must have produced them unconsciously before that time—was Thomas Fairchild, who must be known to many people as the originator of the flower sermons now so common in many churches. The hybrid which he produced was a cross between a sweet william and a carnation pink, and something very much like it was still in existence. From that time, however, progress was slow until Linnæus was struck with the same phenomenon; while Thomas Andrew Knight, a former President of the Royal Horticultural Society, and Dean Herbert were celebrated for their work in the same direction. In their day there was a great prejudice against hybridization among certain religious people. It was said that by the cross-breeding of plants people were flying in the face of Providence and that the process was wicked. But Dean Herbert showed that by crossing two species of daffodils which he found on the Pyrenees he could produce

*From reports in the London *Times*.

flowers similar to those which abounded in that locality; and he, therefore, argued that if Nature did the same thing he must not be blamed for doing what Nature did. The prejudice against hybridization was carried so far that nurserymen were afraid to exhibit hybrid plants in the Royal Horticultural Society's gardens, because they might injure the feelings of some over-sensitive religious persons; and they, therefore, exhibited them as wild species from abroad. Dean Herbert did much to break down that prejudice. They now had to meet a prejudice of another kind, of which he felt ashamed. He meant the prejudice which existed in the minds of some botanists against hybridization. He could understand how vexed botanists were to find their pretty little systems upset by the proceedings of hybridists. But he thought it was far preferable to uphold the interests of science and truth than of their petty systems. After referring to Darwin's views on species, he said that the question of species, as they understood it, was merely an individual opinion, and that there was no dividing-line between species, varieties and genera. And as to crossing between species not being hybridizing, as some persons asserted, he said that they desired to deal with hybridization in its widest sense, in the full confidence by so doing they would be not only advancing science, but also adding enormously to the welfare of humanity.

Papers were then read on 'Hybridization and Cross-breeding as a Method of Scientific Investigation,' by Mr. W. Bateson, F. R. S., Cambridge; 'Hybridization as a Means of Pangenetic Infection,' by Professor Hugo de Vries, Amsterdam; 'Hybridization and its Failures,' by the Rev. Professor George Henslow, London; 'Progress of Hybridization in the United States of America,' by Professor L. H. Bailey, Cornell University, U. S. A.; and 'Experiments in Hybridization and Cross-breeding,' by Mr. C. C. Hurst, Burbage, Hinckley.

The chair was taken by Professor G. Henslow on July 12th, who, in his opening remarks, said that these meetings were of great value, because they connected together scientific and practical work. The questions dealt with applied not only to hybridization, but also to all parts of botany; and botanists would be only too thankful to get hold of facts with which the horticulturist was familiar.

Mr. Herbert J. Webber, from the United States Department of Agriculture, gave an interesting lecture, with lantern demonstration, on the work of his department in plant hybridization. He said that the work of hybridizing was started not more than three years ago, and the results attained were far from complete. All the plants on which they had worked were, in the main, horticultural products of America, and one of the principal was the orange plant. A few years ago almost the entire orange industry for a season in Florida was destroyed by frost in a single night, and about a hundred million dollars was lost by the damage done. In consequence of this they arrived at the conclusion that either they must abandon the orange industry in Florida or secure a variety of orange which was very much hardier and which would resist the frost. Accordingly, they set to work to hybridize the Japanese orange, *Citris trifoliata*, with the sweet orange. The *trifoliata* was found as far north as New York, and was used as a hedge plant. The fruit was bitter and resinous, and was used as a preserve fruit; but the plant was hardy in character, and by hybridizing it with the common sweet orange it was hoped that the frosts would be resisted and that they might obtain hybrids of the two species and a deciduous as well as an evergreen orange. After illustrating the new plants by means of the

lantern, Mr. Webber said that the true hybrid plants had been found very much more vigorous than the common sweet orange. His department had also made experiments with the view of combining the character of the tangerine with the common orange in order to secure, if possible, the loose skin of the tangerine with the common variety. The sweet orange was of much better quality and more desirable than the tangerine, but if by hybridizing they could produce a fruit to combine the characters of the two he thought that such a fruit would take the market; and they were working on those lines. They were further endeavoring to improve the quality of the orange by crossing the bitter-sweet pomelo with the sweet orange. He gave illustrations of the different foliage and developments of the plants brought about by hybridizing. The United States Agricultural Department had, he said, also been working more or less with pineapples; and he pointed out that it had been ascertained that by the crossing of fruits which were commonly seedless they could frequently produce seeds, and that the plants so dealt with were more vigorous and better able to resist disease. Another branch of their work was with cotton plants, the main point being to hybridize between the Upland cotton and the so-called Sea Island cotton. The improvements obtained Mr. Webber illustrated by means of the lantern slides, and said that by this hybridization they hoped to extend the cotton industry considerably. The last experiment dealt with by the lecturer was the hybridization of corn (maize) by introducing the wild species into the cultivated strain. They were endeavoring to cross the common maize with the wild Mexican grass Theosinth, which was supposed to be the progenitor of maize; but, of course, there must be numerous generations before they could bring out the character of the corn to any great effect.

The following papers were also read: 'The Structure of certain New Hybrids (Passiflora, Albuca, Ribes, Begonia, &c.),' with lantern demonstration, by Dr. J. H. Wilson, St. Andrews; 'Hybridization viewed from the standpoint of Systematic Botany,' by Mr. R. Allen Rolfe, Kew; 'Hybrid Poppies,' by M. Henry de Vilmorin, Verrieres; 'Self-Fertilization of Plants,' by M. Lemoine, Nancy; 'Hybrid and Cross-bred Fruits,' by Mr. Luther Burbank, San Rosa, California, U. S. A.; and Mr. T. Francis Rivers, Sawbridgeworth.

The festival dinner of the Conference was held at the Whitehall Rooms, Sir Trevor Lawrence presiding. The toast of 'The Queen, Patron of the Society,' having been honored, the Rev. Professor Henslow proposed 'Horticulture,' and Mr. H. J. Webber, in responding, said he brought with him the friendly greeting of the United States Secretary of Agriculture. He added that he hoped to see the time when the originator of a new fruit or flower, in addition to the satisfaction he might feel in conferring a benefit on humanity, would receive the just and practical recompense to which he was entitled. Professor Hugo de Vries (Amsterdam University) and M. Henry de Vilmorin also responded. Mr. Bateson proposed the toast of 'Hybridists,' Mr. W. T. Swingle (Washington) responding. The Master of the Rolls gave 'The Royal Horticultural Society,' and referred to the early work of the Society in sending out investigators into various parts of the world. The Chairman, in reply, said it was owing to the work of Robert Fortune, who was sent by the Society into China, that the cultivation of the tea plant was introduced into India and Ceylon and an immense trade was thus almost wholly transferred from China. The Society, which was founded in 1804, would soon have to consider how it was to celebrate its century. Of late years the Society had been progress-

ing by leaps and bounds, but it needed a hall in London and a new garden in place of the old garden at Chiswick. The Belgian Minister responded for the visitors.

SCIENTIFIC BOOKS.

German Higher Schools: the History, Organization and Methods of Secondary Education in Germany. JAMES E. RUSSELL, PH. D., Dean of Teachers College, Columbia University. New York, London and Bombay, Longmans, Green & Co. 1899.

The magnificent spectacle of German education is something which it is of extreme importance for our own progress, as well as of great interest as an intellectual phenomenon, that we should thoroughly understand. Nothing that has hitherto appeared on the subject is to be compared for comprehensiveness of character or for vividness of presentation with this work of the Dean of the Teachers College of New York. If all works on education were as interesting as this the science of pedagogy would not be the dreary burden which it is now to most persons of any spirit or of any feeling for logical structure. And if the science of pedagogy had more frequently proved attractive to the better order of writers, who knows how much farther advanced the art and practice of teaching might have been than it now is?

Mr. Russell has been European Commissioner of the Regents of the University of the State of New York, and special agent of the Bureau of Education for the study of German schools. He has thus had unusual opportunities for carrying out his investigations; school officials, high and low, have given him generously of their time, and have put him in the way of comprehending the spirit and the ideals of their educational system. The five years that he has devoted to the subject have been put to good use, and their product is a book of an unusual degree of value. We can only touch upon a few of the more striking characteristics of the German system of education as here depicted.

Of first importance, and far more striking than anything that is said in regard to the system of instruction, is the preparation to which the German teacher must be subjected before he can enter upon his career. It should be premised that there are no exceptions in Germany, and that these regulations must be complied with by absolutely every one who proposes to become a teacher in a higher school. After his nine years' course in a gymnasium the candidate for this profession enters the University, where his studies can nominally be completed in three years, but where, as matter of fact, he is sure to spend from four to five years of hard work. He then presents himself for the State examination, the sole test of a candidate's preparation for any professional career, which neither the degree of Doctor of Philosophy nor any other scholarly distinction can enable him to dispense with. The examining board (consisting chiefly of university professors) he must satisfy (1) of his proficiency in pedagogy and philosophy, including psychology, logic and ethics; (2) of his familiarity with the German language and literature; (3) of his acquaintance with the doctrines of religion, and (4) of his thorough knowledge of the special subjects which he expects to teach. These latter subjects must be at least four in number, two major and two minor, and he must never presume to teach any subject in which he has not received a certificate, nor to any extent beyond that corresponding to the grade of his certificate—first, second or third. (There are certain restrictions limiting his combination of subjects; for example, with any grade of French or English, he must have at least third grade Latin, and if one of his majors is religion the accompanying one must be Hebrew.) As a general thing, the future teacher does not take the degree of Ph. D. at his university; that is a luxury costing from one to two hundred dollars, besides the time spent in the preparation of a thesis; and the Staats-Examen is regarded as more of a distinction than that leading to the degree, besides being, in any case, obligatory. The application for examination is itself a serious affair. There is a fee of thirty marks to be paid for each examination; then there are certificates and testimonials to be furnished of the candidate's whole course of preparation, showing precisely what he has done and what his standing has been during his whole school life from the age of nine years; then there is

his *Vita*, in which the candidate tells when he was born, the rank or occupation of his father, his religious adherence, etc.; this is to be written in Latin if his subjects are the classical languages, and in French or English if they are the modern languages. His application is not regarded as satisfactory if the commissioners are left in any doubt as to his moral character, or if they suspect him of being disloyal in either religion or politics. But after all these requirements have been met, and the examination has been successfully passed, the candidate is by no means ready to enter upon his profession; two years of purely pedagogical training must follow, first a year of study in a pedagogical seminary, and then a year of trial-teaching, under inspection. For this year of teaching he receives no remuneration, and if his work is not satisfactory he may, on the report of his director, be dismissed from the service. This last year of his preparation has brought him, counting in the one year of military service which he must have passed through, to the age of twenty-six at the very least, and more frequently he is two or three years older than that; having reached this stage his name is inscribed on the list of teachers eligible to appointment, and after a period of waiting, which lasts on the average from five to six years, he is at the end sure of an occupation for the rest of his life, and of a decent retiring pension at the close of his term of service.

In comparison with the easy-going methods which we are accustomed to in this country, all this looks like hardship in the extreme for the poor teacher. But what admirable provision it makes for the training of the coming scholar! With an educational system which is laid out on such a scale as this, it is no wonder that learning and research have their home in Germany, and that in industrial matters as well England and France have discovered that their supremacy is in imminent danger of passing away. The great pressure in Germany upon the means of subsistence, and in particular the extreme social prestige which attaches to the occupations which presuppose learning, and the social repression which is exerted upon those whose wealth is their only claim to recognition, have brought it about that the profession of teacher, whether in high school or in university, is one of extreme attractiveness; it follows from this that young men are willing to undergo long and expensive training for the privilege of entering it, and that the requirements can be made more and more exacting with only the result of securing better and better material. If a high civilization consists in a form of society in which the real things of life receive their rightful appreciation, in which an unselfish devotion to learning, to art, and to the discharge of the duties of public office is the quality above all others which is rewarded with the respect and honor of the whole community, then Germany may well claim to be at the present moment the most civilized nation upon the face of the earth. Certainly there is no other country where the art of securing the comforts, the artistic enjoyments, and, to a large extent, the elegances of life for a small expenditure of time and of money has been brought to such a state of perfection as here. This is largely, of course, because the Germans are free from the vulgar love of luxury and passion for display which the higher classes, that is, the intellectual classes, have not wholly succeeded in putting down in England and America; 'conspicuous consumption,' to use the happy characterization of Mr. Veblen, has not for them the baneful attractiveness which it has for the English and the Americans.

This is the bright side of the picture. The other and painful feature of intellectual life in Germany is that it is the possession of one-half of the population only; the women have thrown away the inheritance which should have been theirs from their splendid early German ancestors, and have sunk low in the abyss of household drudgery. The only way to effect a change in this sad state of things is to begin at the top; when it has once become not only possible, but a matter of course, for the clever woman to follow university courses, the standard as regards the proper consumption of time will be quickly raised throughout all ranks; professor's wives will no longer sit up all night to finish Christmas presents in worsted work as they do now, but will save their eyes for better uses. Great changes have been effected in

Germany during the past few years, and there are hardly any universities remaining which offer no facilities for the higher education of women, but these changes have been brought about by the courageous and energetic work of a few fair-minded professors, and in the face of the fanatical opposition of the great majority of them. "The boasted freedom of the universities is again contradicted in their attitude towards the education of women. No one expects the state to be liberal, but liberality is looked for in the highest educational centers of the country. But with what results? Determined, almost fanatical, opposition to the extension of university privileges to women * * * For those women who desire to secure a broader education than is afforded by the girls' schools, and who can easily enough take up university work and profit from it, there can be no valid reason for keeping them out. It makes one lose faith in the ideals of university enlightenment" (p. 416). Nevertheless, the first German woman has already taken the degree of Doctor of Philosophy at the University of Berlin, and in 1896 six young ladies of high social position, who had been trained by the enthusiastic and devoted Helene Lange, took the final examination set for the boys of a Berlin *Gymnasium*, and received high rank. "It will be seen," says Professor Russell, "that the woman question will soon supersede the Greek question." The crying need for women at present is the foundation of public *Gymnasia* for girls. In spite of several recent setbacks, progress can be safely predicted in this line. The latest news from Germany is that a *Gymnasium* for girls has been started in Hannover, and that the one in Karlsruhe, which has hitherto been in private hands, has been taken over by the city.

We have no space left for discussing German methods of teaching. The most important general difference between them and those which we know in this country is that less is left to the initiative of the scholar; he does much less of his work out of school hours, and the teacher takes a much more active part in the work of instruction. The joy and refreshment which the American boy gets out of his athletics are unknown to the German, but (what we are less in the habit of remembering) he has an immense resource in music, to which he gives a large part of his hours of recreation. As regards special studies, the account given of the new method in teaching modern languages is most illuminating, and gives record of marvellous results. But the whole book will become the useful companion of those who are interested in securing better and better systems in the education of the young.

Christine Ladd Franklin.

Baltimore.

The Native Tribes of Central Australia. By Spencer Baldwin, M.A., and F. J. Gillen. New York, Macmillan Co. 1899.

This work is an important contribution to Australian anthropology, being a careful monograph on the Arunta tribe, with observations on some neighboring tribes, giving an account of ceremonies, traditions, customs and myths. As Mr. Cushing identified himself with Zuni Indians so the authors became initiated members of the Arunta tribe, and thus came into intimate knowledge of many facts of great interest, especially as throwing light on Totemic organization. The Totemic myths and ceremonies are treated in great detail. The Totem groups at the time of the year when rain may be expected and food animals breed, conduct simple ceremonies of chants of invitation, with representative plays which will insure the multiplying of the food. These ceremonies are essentially childish, are in the same spirit as the 'rain, rain, go away, come again another day' of civilized children. While these ceremonies do not appeal to supernatural beings, that is beings who are over rain, kangaroos, etc., but to the Rain, Kangaroo, etc., as themselves animate beings, yet as conciliatory the acts must be called religious, as coercive, unreligious, and the native mind continually vacillates from one to the other position. As to the origin of Totemism the authors (p. 127) can pronounce no opinion, yet (p. 209) the origin is sufficiently indicated as derived from the dominant food of any section of a tribe. With regard to such a Totem as Rain we see that the whole tribe have a general Rain dance, and the specialization of function is only partial to the Rain group (p. 193).

As to primitive marriage the authors tend toward a promiscuity theory as *versus* Westermarck (p. 111). It is notable that the 'muscle' dance as sexual lure is found amongst the Arunta (p. 381). Religion as mere craft is suggestively noted (p. 130). The intense solidarity and communism of savage life is vividly portrayed in this work. The account of socialization suggests that if we could penetrate animal organization, for example, crows, we might find quite similar methods, a general animistic interpretation and adaptation, and a sort of unspecialized Totemism, for instance, in rain calls. In this work we find plenty of hard dry facts, of external description, thorough and precise, but we have little large, comparative and psychic interpretation. We learn very little of how the natives think and feel. The conservatism of savage life is alluded to, as also the rather narrow but real chance of variation. Their powers of observation and memory in what directly concerns their livelihood is mentioned, as is also their very limited power of numeration. In adaptive intelligence they are in one point inferior to the elephant, who thatches himself, for though the Australian has warm skins of kangaroo he has never thought to use them as defense from the cold which often goes below freezing point. As clothing is unknown to him, we must revise our definition of man as an animal that wears clothes.

The authors are far from making clear the concept of the natives as regards the life of the individual after death. They continually use the word 'spirit'; but the essence or vital core of the individual which changes residence is really concrete (pp. 137 and 516), and it seems obvious that the natives have not risen to the idea of body and spirit. It would certainly be highly desirable that a skilled psychologist should closely interpret the psychic basis of the ceremonies, etc., described, should study emotions and their expressions, and test the psychic power of the natives in various ways.

The work has good maps and photographic illustrations. Some of the faces and figures are finely sculpturesque, for example pages 35 and 43, and the full face, p. 38, is a veritable Olympic Zeus.

HIRAM M. STANLEY.

Guide to Excursions in the Fossiliferous Rocks of New York State. By JOHN M. CLARKE, State Paleontologist. June, 1899. Pp. 1–120. Or Handbook 15, University of the State of New York.

This booklet is somewhat of a novelty in American geological literature. Every student of geology knows that New York State is classic ground for many of the Paleozoic formations of America. But a knowledge of how to see the various formations and collect their characteristic fossils to the best advantage in the shortest time and with the least expense can be obtained only after much experience. Here, however, most of this information is at hand and students of geology can go directly to classical localities and lovers of nature to some of the prettiest spots in the State.

In this booklet are described in detail 27 excursions, each demanding from 1 to 7 days. All of the trips can be made in from 56 to 72 days. The best and most readily accessible sections are described and directions given to railroads, the places to stop over night and the localities and beds furnishing characteristic fossils from the Cambrian to the Chemung, including the post-Glacial clays.

It is to be hoped that other States will profit by New York's example and that similar booklets for Maryland, Ohio, Indiana, Illinois and Iowa will follow.

C. S.

BOOKS RECEIVED.

Praxis und Theorie der Zellen und Befruchtungslehre. VALENTIN HÄCKER. Jena, Gustav Fischer. 1899. Pp. viii + 260. Mark 7.

Physical Nature of the Child. STUART H. ROWE. New York and London, The Macmillan Company. Pp. xiv + 206. $1.00

The Elements of Physics for use in High Schools. HENRY CREW. New York and London, The Macmillan Company. 1899. Pp. xiii + 347. $1.10.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for July opens with an article by T. H. Montgomery, 'Observations on Owls, with particular regard to their Feeding Habits,' which clearly demonstrates the comparative abundance of small rodents as well as the numbers destroyed by owls.

Incidentally it shows with what regularity these birds resort to certain chosen roosting places. J. H. Comstock and J. G. Needham bring to a conclusion the fourth chapter on 'The Wings of Insects,' which treats of 'The Specialization of Wings by Addition,' and terminates that portion of the series devoted to furnishing data for determining the homologies of the veins. Arnold E. Ortmann discusses 'New Facts lately presented in opposition to the Bipolarity of Marine Faunas,' stating that they do not at all support the theory of bipolarity and that we must wait for further investigation to show whether bipolarity as a relic of older times is realized in the distribution of any marine animals. The first of the promised 'Synopses of North American Invertebrates,' by C. B. Davenport, is devoted to the 'Fresh-water Bryozoa.' A brief sketch of the habits and habitats of these animals is given, followed by a key for their specific determination and a bibliography of literature on Fresh-water Bryozoa. W. E. Praeger presents some 'Notes on the Habits of Bascanion Constrictor,' which contains good evidence as to the climbing abilities of this snake. Leonhard Stejneger, under the title 'A New Name for the Great Crested *Anolis* of Jamaica,' shows that there has been a curious unanimity in misnaming this reptile *Anolis edwardsii* and proposes for it the name of *Anolis garmani.*

The June number of the *Journal of the Boston Society of Medical Science* brings the third volume of this periodical to a close. The index shows that it contains sixty-five papers contributed by forty-five investigators. While there is a greater tendency towards pathological subjects than formerly, there is yet very much of interest to the comparative anatomist. In the present number Calvin G. Page has a 'Study of Streptococci isolated from Throat Cultures from Patients Ill with Scarlet Fever,' and a 'Preliminary Report on the Diplococcus of Scarlet Fever.' Theodore Hough and Bertha G. Ballantyne give a 'Preliminary Note on the Effects of Changes in External Temperature on the Circulation of Blood in the Skin,' and S. A. Hopkins presents a preliminary report on 'Bacteria and Dental Caries,' stating that he has not yet been able to deduce from his experiments any definite laws or positive results. Theobald Smith describes and figures 'Some Devices for the Cultivation of Anaërobic Bacteria in Fluid Media without the Use of Inert Gases.'

DISCUSSION AND CORRESPONDENCE.

ABOUT A REFORM IN NOMENCLATURE.

In the 'Nomenclator Zoologicus' of Scudder 80,000 genera are mentioned and there are 7,585 genera of phanerogamia. Human memory is unable to retain all these arbitrary names (languages have from 20,000 to 30,000 words each) and the result of it all is that "the language of science is more difficult than science itself." Even professed naturalists cannot guess what the *Mormops megalophylla* or the *Ceroplastes psidii* is. It is high time to repair this mischief by introducing the reform following:

1. The generic names of animals shall end in *us*, those of plants, in *a*, and those of minerals in *i*.

2. Minerals shall have a genus formed with the abbreviations of their components. Thus *Sulphurzinci sphalerita* indicates a mineral (i), a Sulphur (Sulph.) of zinc (zinci), of the species *sphalerita*.

3. Plants shall have their genus preceded by the abbreviation of their family. Thus *Rosaspiræa limbata* indicates a Rosacea (Rose), of the genus *spiræa* and the species *limbata*, plant (a).

4. The genus of animals shall be relegated to special lists, substituting for those in common use the abbreviations of their class and family or order. Thus *Inscoccidus psidii* indicates an animal (us), insect (ins.), coccidæ (coccidus) belonging to the species *psidii*. The family (Cocciceroplastus psidii) is more difficult of interpretation, since at least 1,000 families of animals have been accepted.

5. In case there be two similar species in the same family of animals their genus shall be cited.

The reform proposed does not alter or change anything, but facilitates research, as well as the applications, popularization and teaching of science. There are no future inconveniences in the acceptance of this reform. No Inter-

national Congress is required, since the abbreviations present no difficulties.

A. L. HERRERA.

MUSEO NACIONAL, MEXICO.

TIDES AND CURRENTS IN CANADIAN WATERS.

TO THE EDITOR OF SCIENCE: Permit me to invite your attention to the latest report of the engineer in charge of the survey of the tides and currents of the coast waters of Canada, Mr. W. Bell Dawson, M. A., M. E., etc., a copy of which has been addressed to you. This survey, commenced by the government of Canada in 1894, is of great importance, not merely in the interest of hydrographical science, but of the large and increasing trade which finds its way along the Gulf and River St. Lawrence, the greatest waterway from the north Atlantic into the northern part of the American continent, and which, like all similar tide-ways, is affected by the complex action of the tides and consequent currents.

It is much to be regretted that the economy or parsimony of the government has caused a suspension for the present of the special survey of the currents, and has restricted the work to tidal observations, which, though of great value to the shipping interests, can only be considered as preliminary in regard to the investigation of the currents themselves, which lead to so many losses of property and life, and tend to high rates of insurance, injurious to the ship owners and merchants of Canada, and, through them, to those of an empire as a whole.

The present report, in addition to what can be done with the insufficient grant allowed in the matter of tide-gauges and tide-tables, has reference to the behavior of the gigantic tides of the Bay of Fundy, when confined by the converging coasts at the head of the bay, and their relation to the smaller tides on the opposite side of the isthmus connecting Nova Scotia and New Brunswick, at Bay Verte, on the Gulf of St. Lawrence. These and the phenomena of the 'bore' at the head of the Bay of Fundy are here for the first time described, illustrated by maps and sections, and tabulated, and will be found of the greatest interest by all who desire information as to the exceptional tides of this region.

NATURAL HISTORY OF THE TRES MARIA ISLANDS, MEXICO.

THE latest publication from the Division of Biological Survey of the U. S. Department of Agriculture, being 'North American Fauna, No. 14,' bears the title at the head of this notice. It contains the result of an exploration made in the spring of 1897 by Mr. E. W. Nelson and Mr. E. A. Goldman during the month of May of that year, and adds largely to our previous knowledge of the fauna and flora of these islands. The more appropriate title to the paper would be 'Contributions to the Natural History,' etc., for no *insecta* are mentioned and *only six* species of mollusks; of these *four* had not been previously known to occur. The author, after mentioning the names of Col. A. J. Grayson and Alphonse Forrer, says 'no other naturalist is known to have visited the islands until the spring of 1897,' the season of his visit. He should have known that the islands were visited in the spring of 1876 by Mr. W. J. Fisher, previously naturalist of the Tuscarora Telegraph Sounding Expedition, directed by Commander George E. Belknap in 1873. Mr. Fisher made a large collection of molluscan forms as published in the Proc. U. S. Nat. Museum, pp. 139–204 of Volume XVII., 1894, wherein 89 species are listed.

It is not unlikely that both Grayson and Forrer collected many insect species which have been published somewhere. Only the mollusks collected by Fisher have come under my notice.

ROBERT E. C. STEARNS.

LOS ANGELES, CAL., June 26, 1899.

NOTES ON INORGANIC CHEMISTRY.

No little work has been done on the compounds of sulfur and iodin, but with no very satisfactory results. The latest contribution is by L. Prunier in the *Journal de la pharmacie et de la chimie*, and it can hardly be said that the subject is left in a much clearer condition. Prunier distinguishes between what he calls 'iodized sulfur' and 'sulfur iodid.' The former is made by adding the desired quantity of iodin to sulfur at 115° to 120°, stirring, cooling and preserving in a stoppered bottle. The iodin

volatilizes very readily and is rapidly extracted from the finely pulverized substance by sodium thiosulfate solution. The sulfur left after the extraction of the iodin is readily soluble in carbon bisulfid. It would seem that in the 'iodized sulfur' the iodin is merely dissolved in the sulfur. The 'sulfur iodid' is prepared by adding pulverized iodin to sulfur heated to 200°. While cooling, the mass is poured into cold water and then powdered. The iodin cannot be dissolved out by thiosulfate solution and seems to be in chemical combination. The color of the sulfur iodid is yellowish red; that of the iodized sulfur brownish black. Both substances, especially the latter, are energetic therapeutic agents.

The question of the form in which iodin occurs in the sea water has received a new answer from Armand Gautier in the *Comptes Rendus*. It is questionable how much experimental evidence can be deduced to show the presence of sodium iodid or calcium iodate, though both of them have been proposed. Gautier claims that all the iodin in sea water is in the form of organic compounds. About one-fifth is combined in algæ and spores, and the remainder in the form of soluble organic compounds; the latter are in part derived from the decomposed algæ, and are in turn assimilated by other algæ. It would be an interesting thing to have this question settled once for all, but the problem is one of great difficulty.

There is also presented in the *Comptes Rendus* a study by M. De Forcrand of the chemical function of water compared with that of hydrogen sulfid. From the heats of formation of the oxids of sodium the author concludes that the two hydrogen atoms in a molecule of water are distinctly different in function, and hence that water possesses an asymmetrical formula which he would represent by H — OH. In hydrogen sulfid, on the other hand, he considers the hydrogen atoms of equal value, and it consequently possesses a symmetrical formula H — S — H.

According to the *Pharmaceutische Central-Halle* Varino has succeeded in preparing a colloidal form of bismuth. The very diluted solution of bismuth tartrate in potassium tartrate is treated with a solution of stannous chlorid in caustic potash. A clear brown fluid results, from which very little bismuth precipitates, and which acts toward the electrical current in a similar manner to colloidal gold.

According to the *Chemical News*, one of the the most interesting exhibits at the recent Royal Society Conversazione was the series of experiments by Mr. W. A. Shenstone and Mr. W. T. Evans, showing the manufacture of tubes of rock crystal in the oxyhydrogen blowpipe flame. Tubes of one centimeter in diameter, composed of rock crystal, can now be made of considerable length at the rate of about three centimeters an hour. This is of great practical as well as theoretic interest.

J. L. H.

RECENT PROGRESS IN THE EXAMINATION OF FOODS AND DRUGS.

PLANT PRINCIPLES.

As the result of some investigations on the carbohydrates in bulbs, tubers, etc., L. du Sablon* gives the following information: The reserve materials in the tubers of potato, rhizomes of *Arum* and *Iris* and the corms of *Colchicium* and *Ranunculus* consist almost entirely of starch, with small quantities of dextrin and sugar. In the tubers of *Ophrys* and the bulbs of *Lolium*, *Tulipa* and *Hyacinthus* the reserve is made up of starch and dextrin. In the corm of *Ficaria* starch, dextrin and non-reducing sugars are present. In the tubers of *Dahlia* inulin and levulin are found; whereas in the tubers of the artichokes, besides the inulin and levulin, non-reducing sugars are present. Chiefly reducing and non-reducing sugars are to be found in the bulbs of *Allium* and *Asphodelus*. The experiments of du Sablon seem to show that the starch is transformed into dextrin, then into non-reducing sugars and finally into reducing sugars.

Inulin has been found by H. Fischer† to occur in most of the tribes and a large number of genera of the N. O. Compositæ. It is also found in the Campanulaceæ, Lobeliaceæ, Goodeniaceæ, Stylidaceæ, etc. He assigns to it the formula 333 $C_6H_{10}O_5$ or $C_{1998}H_{3330}O_{1665}$.

* Bonniers Rev. Gén. de Bot., 1898; Ibid., p. 295.

† Cohn's Beitr. Biol. Pflanz., 1899, p. 53.

The essential oil of orange flowers (*Citrus aurantium amara* L. and *C. bigaradia* Dick) has been examined by E. and H. Erdmann,* and they find it to contain (0.129 gms. per kilo of oil) anthranilic methyl ester. It is supposed that the fluorescence of the oil is due to this ester.

Jasmal, or methylene acetal of phenyl-glycol, is the name given by A. Verley † to a principle which he has made synthetically and which it is claimed possesses the characteristic odor and other properties of the principal odorous principle of jasmine. The West Indian sandalwood oil ‡ is recognized by E. M. Holmes as coming from a new genus and species of the N. O. Rutaceæ, and named by him *Schimmelia oleifera*.

The oleoresin of *Dacryodes hexandra* Griseb. (N. O. Burseraceæ) has been found by A. More § to consist of an essential oil, a resin and a crystalline substance. The oil contains lævorotatory pinene and lævorotatory sylvestrine. The crystalline principle is insoluble in water and is only sparingly soluble in strong alcohol, and appears to be identical with Personne's ilicic alcohol.

Gum M'beppe, or Kongosita, has been identified by E. Heckel ‖ as the product of *Sterculia tomentosa* Guill et Perrot. It is distinguished from tragacanth in that it does not give any coloration with iodine and yields 7.24 per cent. of ash.

According to F. C. Newcombe ¶ the enzyme of *Asperigillus oryzæ* acts with greater intensity upon reserve cellulose than upon starch, while the enzymes of *Lupinus albus* and *Phœnix dactylifera* act so strongly on reserve cellulose and so feebly upon starch that they may be regarded as cystase rather than as diastase. S. H Vines ** has continued his studies on the enzyme of *Nepenthes* and says that, like all the vegetable proteolytic enzymes, it is probably tryptic in character, being more stable in its nature and more rapid and energetic in its action than that contained in germinating seeds, which it closely resembles.

* Ber. d. D. Chem. Ges., 1899, p. 1213.

† Bull. Soc. Chim., 1899, p. 226.

‡ Pharm. Jour. (London), 1899, p. 53.

§ Chem. News, 1899, p. 284.

‖ Ext. Rev. d. Cult. Col.; through Pharm. Jour., 1899, p. 139.

¶ Annals of Botany, 1899, p. 49.

** Ibid., p. 545.

FOODS AND SPICES.

AT a recent meeting of the Incorporated Society of Medical Officers of Health,* England, the following resolutions were adopted: (1) 'That the Incorporated Society of Medical Officers of Health strongly disapproves of the practice of adding preservative chemicals to milk and other foods;' (2) 'that if preservative chemicals be added to any food a full disclosure as to the nature and amount thereof should be made.'

It is not unusual to find some of the exhausted umbelliferous fruits in adulterated pepper, but T. F. Hanausek † records for the first time the employment of exhausted coriander to adulterate a sample of pepper.

A. Juckenack and R. Sendtner ‡ have examined the fennel from Germany, Italy, Macedonia and Galicia. They find in all cases upon placing the exhausted fennel in water that the fruits become dark colored and sink, whereas the genuine fruits retain their color and float. Upon making a microscopical examination a marked difference is also observable. The author also notes that from 70 to 80 per cent. of the fruits of fennel should be capable of germination. He has not found any specimens in which chrome yellow was used to improve the appearance of the fennel, although he has met some samples in which ochre had been employed.

The ash of the fruits and seeds of *Ellettaria cardamomum* Maton (N.O. Zingiberaceæ) always contain manganese. According to W. W. Will § the ash is found in the following percentage in the different parts: (1) whole seeds, 3.26; (2) crushed seeds, 3.52; (3) pericarp of fruit, 5.96 to 6.17; (4) entire fruits and seeds, 3.84 to 4.22.

A sample of coffee which had caused symptoms of poisoning in the members of a family drinking the infusion was examined by S.

* The Analyst.

† The Analyst.

‡ Zeitschr. f. Nahr. u. Genuss., 1899, No. 4.

§ Chem. News, 1899, p. 167.

Bein.* He failed to detect the usual metallic or alkaloidal poisons, but found a ptomaine, which arose probably either through the spoliation of the coffee by means of sea water or by overroasting the product. Massee,† describes a blight (*Pestallozzia guepini* Dermaz) which occurs on the tea plantations of Assam and is doing considerable damage.

The well-known property, which formaldehyde possesses, of forming insoluble compounds with proteid substances, and applied by Beckmann to the estimation of gelatin and albumin in peptones, has been recently applied by Trillat ‡ to the detection and estimation of gelatin in general and especially when mixed with gums.

In the examination of various cereals A. van Bastelaer § finds that upon heating 1 part of the cereal with 5 parts of water at a temperature of 11 to 12° C. for 1 hour that certain characteristics are brought out; rye giving a rather viscous solution; linseed and buckwheat yielding a thick mucilage; whereas wheat, rice, spelt, barley and oatmeal give solutions of rather even viscosity. He further finds that the leguminous cereals, upon shaking the solutions, develop a large amount of froth, whereas the solution of corn does not froth. All of the cereals, with the exception of rice, yield a precipitate with picric acid, the largest amount of precipitate having been produced with the leguminous cereals. Alcohol, likewise, produces a precipitate with solutious of rice, barley, buckwheat and the leguminous cereals the precipitate of the leguminous cereals and flaxseed being soluble in ammonia.

HENRY KRAEMER.

PHILADELPHIA COLLEGE OF PHARMACY.

* Zeitschr. f. angew. Chem., 1898, 658; Analyst, 1899, p. 36.

† Pharm. Zeit., 1899, p. 749.

‡ Ann. Chim. Anal. App., 1898, p. 401; Analyst, 1899, p. 35.

§ Jour. Pharm. Chim., 1898, VIII., 43; Pharm. Centralb., 1899, p. 303.

POSITION OF WOMEN IN BABYLONIA.

A RECENT treatise by Victor Marx defines the position of women in Babylonia during the period 604–485 B. C., as illustrated by the contract literature of the times; his treatise forms half of Heft 1, Band IV., of the Beiträge zur Assyriologie und semitischen Sprachwissenschaft, Leipzig, 1899; and is reviewed at some length by J. Dyneley Prince in the *American Journal of Philology*, Vol. XX., pp. 104–106. The contracts indicate that Babylonian maidens held property in their own right, and that there were definite marriage stipulations relating to dowry, incidentally indicating the dependence of the son on his father's wishes in the choice of a wife. The dowry contracts were definite, stating the amount and nature of the property to be given, providing for payment by instalments and arranging for payment by a brother in case of the father's decease, the dowry being regarded as a legally collectable debt, payable in kind if money were lacking. The legal recipient of the dowry was the son-in-law, yet the daughter (wife) retained such proprietary interest therein that if invested in realty by the husband it was in the wife's name. Married women were competent to conduct transactions relating to money, to realty, and to slaves, their contracts being sometimes witnessed by the husband; while various business transactions were performed in common by husband and wife, the former being alone responsible as guarantor, the mere presence of the wife giving legality to the husband's transactions, at least in certain cases. There are indications that husband and wife enjoyed approximately equal rights with respect to property, the control of children, etc.; there is little reference to the husband's duty to support the wife, though it appears that in case of divorce the husband paid alimony according to his means. Frequent reference to slaves appears in the contracts, but the author postpones discussion of the subjects of slavery and of the condition of female slaves. The information brought to light through the study of these ancient contracts bears on the development of institutions. Apparently the regulations governing the contracts studied pertained chiefly to urban life; certainly the regulations seem hardly in accord with the customs prevailing among contemporary nomadic tribes and still maintained among their descendants of similar habit.

W J M.

AMERICAN MATHEMATICAL SOCIETY.

FOR several years the need of greater facilities for the publication of mathematical investigations has been strongly felt by the members of the American Mathematical Society. This Society has maintained during the past eight years an historical and critical review, known as the *Bulletin of the American Mathematical Society*, and throughout the whole of this period there has been a constantly growing demand for the publication in the pages of this journal of articles not properly falling within its scope. The Society, feeling that the time has come when further provision must be made for the publication of such articles, recently invited the cooperation of several American colleges and universities in a plan whereby such articles may be afforded suitable means of publication.

The necessary cooperation has now been secured, and the publication of the *Transactions of the American Mathematical Society* has been definitely undertaken to begin January 1, 1900. The cooperating institutions are Harvard University, Yale University, Princeton University, Columbia University, Haverford College, Northwestern University, Cornell University, The University of California, Bryn Mawr College and The University of Chicago. It is the desire of the Society that the *Transactions* may cooperate with existing journals in developing a wider and more active interest in mathematical research. Among American journals the *Annals of Mathematics* will encourage papers of pedagogic nature and brief researches of general interest; the *Bulletin of the American Mathematical Society* will maintain its character as an historical and critical review, and the *American Journal of Mathematics* and the *Transactions of the American Mathematical Society* will together, it is hoped, afford adequate facilities for the publication of the rapidly increasing volume of the more technical mathematical papers.

The *Transactions* will be devoted primarily to research in pure and applied mathematics. The editors will welcome all papers containing investigations of sufficient mathematical interest and value. Such papers, in many cases, will be, necessarily, of considerable length; but the editors will be very glad to receive, also, short contributions which are of such a character as to fall within the scope of the *Transactions*. Papers from mathematicians not belonging to the Society will be welcomed; such papers, if accepted for publication, will be presented to the Society by the editors.

The *Transactions of the American Mathematical Society* will be published quarterly. The first number will appear January 1, 1900. The page of the *Transactions* will be the same size as that of the Berlin *Sitzungsberichte*. The subscription price for the annual volume of at least four hundred pages is five dollars, twenty shillings, twenty Marks, or twenty-five francs. A reduction in price will be made, however, to the members of the American Mathematical Society. Subscriptions and payments should be sent to the office of the American Mathematical Society, 501 West 116th Street, New York. Cheques and postal money orders should be made payable to the American Mathematical Society.

Manuscripts intended for publication in the *Transactions* should be addressed either to Professor E. H. Moore, University of Chicago, Chicago, Ill., or to Professor F. W. Brown, Haverford College, Haverford, Pa., or to Professor T. S. Fiske, Columbia University, New York, N. Y.

SCIENTIFIC NOTES AND NEWS.

LORD KELVIN, who for fifty-three years has occupied the chair of natural philosophy at Glasgow, presented to the University Court on July 13th a petition for leave to retire. The Court granted the leave asked, and accepted Lord Kelvin's resignation with deep regret. A remit was made to the Principal to prepare a minute to be signed by all the members of the Court, expressing their sense of the great loss that the University is now to sustain.

PROFESSOR F. ZEEMAN, of Amsterdam, has been awarded the Baumgartner Prize of the Vienna Academy of Sciences, and Dr. K. Natterer, docent in chemistry in the University of Vienna, the Lieben Prize of the Academy.

THE Academy of Sciences of Berlin has given Professor Engler 4,000 Marks for work in botany.

THE third Conference of Astronomers and

Astrophysicists will be held at the Yerkes Observatory on Wednesday, September 6th, and the two following days.

A MONUMENT to Gauss and Weber was unveiled at Göttingen on June 17th, the chief address being made by Professor Voigt, Weber's successor. As part of the ceremonies the honorary doctorate was conferred on Professor Moore, of Chicago; Professor Darwin, of Cambridge; Professor Hadamard, of Paris; Professor Lorenz, of Leiden; Professor Righi, of Bologno, and Professor von Sterne, of Vienna.

THE Volta Exhibition at Como has been completely destroyed by fire, attributed to the fusing of electric wires. Many precious relics of the great electrician were lost in the flames, notwithstanding the precaution taken to preserve the objects by placing them in a receptacle of solid masonry. The committee has decided that the *fêtes* in honor of Volta shall be continued. The International Congress of Electricians will also be held, as previously arranged.

IT is reported that Mr. R. T. Glazebrook, Principal of University College, Liverpool, has been appointed Director of the recently established National Physical Laboratory of Great Britain.

SIR WILLIAM MACCORMAC has been for the fourth time elected President of the Royal College of Surgeons, London.

DR. J. WIESNER, professor of plant physiology, of the University of Vienna, has been elected a member of the Berlin Academy of Sciences.

DR. F. WÄHNER, privatdocent in geology in Vienna, has been elected a member of the Leopoldinisch-Carolinisch Academy at Halle.

A DINNER was given to Sir John Burdon-Saunderson, Bart, and Professor Michael Foster, K.C.B., by British physiologists on July 25th, to congratulate them on the honors recently conferred on them by the Queen.

IT is reported that Professor Sanarelli is about to visit the United States to study the effects of his serum in the treatment of yellow fever.

THE British Cancer Society has commissioned Mr. Arthur C. Buffey, M.B., B.Ch., to go to the United States to report generally on matters affecting the objects of the Society, and especially as to the operations of the State Laboratory for the study of cancer at Buffalo, N. Y.

WE learn from *Nature* that Mr. H. H. Howell, who joined the British Geological Survey under De la Beche in 1850, has retired from the service. Mr. Howell, after surveying some portions of Wales and the south of Scotland, and large areas in the midland counties of England, became District Surveyor of the north-eastern counties of England in 1872; he was appointed Director for Scotland in 1882 (when Sir Archibald Geikie became Director-General), and he was further promoted to be Director for Great Britain in 1888. Mr. Ernest E. L. Dixon, who has for the past two years acted as assistant to Professor Judd at the Royal College of Science, has been appointed Assistant Geologist on the Geological Survey of England.

A MARBLE bust of the late William Rutherford, professor of physiology at Edinburgh, given by his recent students, was unveiled on July 8th. After the bust, which is by Mr. John Hutchinson, had been unveiled, a speech was made by Sir William Turner.

WE regret to learn of the death of Mrs. Elizabeth Thompson, of Stamford, Conn., who made many gifts for benevolent and scientific purposes. She contributed towards the telescope for Vassar College, was one of three 'patrons' of the American Association for the Advancement of Science, and endowed the Elizabeth Thompson Science Fund, the income of which is now being so advantageously used for the promotion of scientific research.

W. P. JOHNSON, LL.D., President of Tulane University, New Orleans, and a Regent of the Smithsonian Institution, died on July 16th.

MR. CHARLES M. FAUNCE, formerly instructor in descriptive geometry at the Massachusetts Institute of Technology, has died at the age of 32 years.

PROFESSOR H. R. GEIGER, from 1846 to 1882, professor of science in Wittenberg College, and

later connected with the U. S. Geological Survey, died at Springfield, Ohio, on July 18th.

DR. WILHELM WHITMANN, professor of mechanical engineering in the School of Technology at Munich, has committed suicide.

MR. J. W. HENDRIE, a Life Member of the California Academy of Sciences, has presented to the Academy, without condition or qualification, securities to the value of $10,000. By action of the Council and Trustees of the Academy, the gift has been set aside to be known as the Hendrie Publication Fund, the interest of which shall be applied towards the publication of the papers of the Academy. Each paper published from the income of this fund will bear the inscription, 'Printed from the Hendrie Publication Fund.'

BY the will of the late Frau M. Jankowska, of Warsaw, the Academy of Sciences at Cracow has received 20,000 roubles.

PRINCE JOHANN LICHTENSTEIN has given the Vienna Academy of Sciences 25,000 florins for explorations in Asia Minor. The Academy has also received 18,000 florins for the increase of the Lieben foundation.

ANDREW CARNEGIE has offered from Scotland to give $50,000 towards a public library building at Steubenville, Pa., if the citizens will furnish a site and maintain it. Mr. Carnegie in his letter refers to his early days when a telegraph operator in Steubenville. His offer will be accepted.

THE Union Pacific Scientific Expedition left Laramie on July 21st. The company was made up of twenty teams and nearly 100 men, including representatives from many leading colleges and universities. The expedition will remain in the field for forty days.

A PARTY of between twelve and fifteen advanced students of geology from the University of Chicago are to make a trip to Arizona and New Mexico during the later part of the summer for field study. The party will leave Chicago on the 10th of August and be gone about five weeks. The party is under the direction of Professor Rollin D. Salisbury, and will in the course of its work make a trip to the Grand Cañon of the Colorado north of Flagstaff. A party of fifteen from the University is now in the field in south-central Wisconsin, and another party is to go into the same region in August. A party of students of botany, under the direction of Dr. Henry C. Cowles, will take a field course during the later part of the summer. These field courses, both in geology and botany, are reckoned as a regular part of the University work.

DR. F. W. SARDESON, of the University of Minnesota, accompanied by Rev. F. S. Moore and W. B. Stewart, has gone on a collecting expedition into the Big Horn River Valley of northwestern Wyoming. The rocks are Tertiary and locally are said to be very fossiliferous. The party will be gone until September. The expenses of the season will be met by several business men of Minneapolis and St. Paul.

AMERICAN men of science visiting Paris may be interested to learn that there are meetings of naturalists held monthly at the Paris Museum of Natural History. They are held at 4 o'clock in the afternoon on the last Tuesday of the month.

A NEUROLOGICAL Society was formed in Paris on June 8th, with Professor Joffroy as President. The Society will issue the *Revue Neurologique*, which will appear on the 15th of each month.

A CONGRESS of Aerial Navigation with M. Janssen as President is being arranged to meet at Paris during the Exposition. There will be five sections devoted respectively to balloons, flying machines, scientific instruments, applications to science and legal questions.

THE British Colonial Office announces that the bubonic plague has spread from Hong Kong and Mauritius to Reunion. There were thirty-six cases at Mauritius during the week ending July 20th, of which twenty-nine resulted fatally.

WE learn from the London *Times* that the annual meeting of the Society of Chemical Industry was opened on July 12th, at Newcastle-on-Tyne. Mr. George Beilby, of Edinburgh, President of the Society, was in the chair. At the Durham College of Science, where the delegates were welcomed to the city by the mayor, Professor C. F. Chandler, of Columbia Univer-

sity, was elected President for the ensuing year. The Council's report, which was adopted, stated that the number of members on the register was 3,312 compared with 3,185 at the last annual meeting. The President, in the course of his address, dealt with the rapid exhaustion of British coalfields and the serious increase of smoke pollution. The remedies were broadly divided into two classes: first, improved appliances for the combustion of raw coal and distribution of the air supply in furnaces; and, secondly, the transformation of the raw coal into smokeless fuel by preliminary treatment. The effects of the natural development of certain industries on the markets for by-products were next considered. It was pointed out that if any considerable part of the 137 million tons of coal which is at present burned in the raw condition were to be converted into gas, coke and ammonia an altogether new condition of things would arise which would need to be foreseen and provided for. A careful study of the whole subject has led to the conclusion that the natural outlet for the coke and pitch would be found in the manufacture of fuel briquettes, and the President advocated the turning of the very best technical skill to the perfecting of the manufacture. He believed that with skill and enterprise it would be possible to make briquettes exactly suited for every purpose from boiler firing to domestic cooking. As a means of bringing all of the different interests which are concerned in this matter into line, it was suggested that the Society might arrange for the holding of a conference on the subject of fuel and smoke, at which the leading technical societies, as well as the actual industries concerned, should be fully represented.

UNIVERSITY AND EDUCATIONAL NEWS.

O. HÖLTERHOFF, a banker of Honnet, has bequeathed his property valued at about 1,000,000 Marks to the University at Bonn.

MRS. JOHN L. NEWBERRY, of Detroit, Mich., has given to Western Reserve University, Cleveland, O., $2,500 to found the Handy philosophical prizes, in honor of her father, Mr. J. P. Handy, of Cleveland.

PROFESSOR BENJAMIN IDE WHEELER, of Cornell University, has accepted the presidency of the University of California.

MR. E. A. MINCHIN, Fellow of Merton College, Oxford University, has been elected to the Jodrell professorship of zoology in University College, London, in succession to Professor W. F. R. Weldon, who, it will be remembered, was recently called to Oxford.

DR. A. FICK, professor of physiology at Würzburg, has retired. The chair was offered to Professor W. Biedermann, but he has refused to leave Jena.

DR. B. PETER has been made associate professor of astronomy at Leipzig and sub-director of the observatory.

DR. A. PHILIPPSON, geography, and Dr. K. Mönnichmeyer, astronomy, docents at Bonn, have been made titular professors.

AN associate professorship for physical anthropology has been established at Zurich and filled by the election of Dr. R. Martin.

AT the University of Paris courses have been authorized by M. Guignard on the application of chemistry to brewing and distilling; by M. Loisel on comparative embryology, and by M. Martel on speleology or subterranean geography.

THERE are during the present summer semester 4,997 students matriculated at the University of Berlin, which is an increase of 349 as compared with last year. There are 655 foreigners.

ACCORDING to the *Hochschul-Nachrichten* 22% of the professors in the German universities are engaged in lecturing or laboratory supervision 2 to 6 hours a week and 51% from 7 to 12 hours. Of the associate professors 60% are engaged from 2 to 6 hours per week and of the privatdocents 82%. Only 4% of all privatdocents are engaged in lecturing or laboratory supervision more than 12 hours a week. The leisure, accompanied it must be admitted by poverty, of the German associate professors and docents explains in large measure the amount of research work accomplished in German universities.

DANIEL GARRISON BRINTON, Professor of American Archæology and Linguistics in the University of Pennsylvania and Professor of Ethnology and Archæology in the Philadelphia Academy of Sciences, one of the editors of this JOURNAL, died on July the thirty-first, in his sixty-third year.

SCIENCE

Friday, August 4, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

We are able to give again this year from official sources certain statistics in regard to the degree of Doctor of Philosophy, together with the names of those who have received it in the sciences and the titles of their theses. It appears from the following table that the doctorate has been conferred by twenty-three universities on 224 candidates.

Universities.	Humanities.	History and Economics.	Sciences.	Total.	Compared with 1889.
Johns Hopkins.........	13	8	17	38	+ 5
Columbia.................	4	6	23	33	+ 9
Yale	11	4	15	30	− 4
Chicago....................	7	4	13	24	−12
Harvard	13	4	7	24	− 2
Pennsylvania	7	5	8	20	− 4
New York................	8	0	1	9	+ 4
Cornell.....................	3	2	2	7	−12
Wisconsin	0	3	4	7	+ 2
Clark.......................	0	0	5	5	− 7
Michigan	1	0	3	4	− 3
California................	0	0	3	3	+ 2
Brown.....................	3	0	0	3	+ 2
Bryn Mawr..............	1	0	2	3	0
Princeton................	0	0	3	3	+ 2
Minnesota	0	1	1	2	+ 1
Virginia..................	0	0	2	2	+ 2
Washington........	0	0	2	2	+ 2
Colorado..................	0	0	1	1	+ 1
Kansas.....................	0	0	1	1	+ 1
Missouri..................	0	0	1	1	+ 1
Nebraska..................	0	0	1	1	− 1
Syracuse	1	0	0	1	+ 1
Total	72	37	115	224	......
Compared with 1898..	− 19	− 1	+ 10	.....	− 10

The table gives a comparison with the data for last year which shows a decrease of ten in the total number of degrees conferred. This is doubtless an accidental variation without significance. The decrease of nineteen degrees in the humanities, under which are included philology, grammar, literature and philosophy, may also be accidental, but the comparatively small number of university doctorates in these subjects deserves consideration. Our educational system is largely based on the study of language, and in view of the great number of teachers required it appears that they are satisfied with a less adequate education than is the case in the sciences. In Germany every gymnasium teacher of Latin or French holds the equivalent of a doctorate, and there is evidently need of a higher standard in America. This year education and sociology have been placed with the sciences. Philology and economics are, of course, also sciences. The division is artificial and made only in respect to the general field covered by this Journal.

Six universities, Johns Hopkins, Columbia, Yale, Chicago, Harvard and Pennsylvania, conferred 169 degrees—more than three times as many as all the other universities combined. Columbia gave this year decidedly the largest number of degrees in the sciences, while Harvard is the only one of these universities in which the degrees in the humanities were more numerous than in the sciences. The degree was not conferred last year by Indiana, Illinois, Stanford, Cincinnati, Columbian, Catholic, Western Reserve, Vanderbilt, or Tulane University. The degrees were in all cases the doctorate of philosophy, with the exception of two doctorates of science, one at Harvard and one at New York University.

The distribution of students among the different sciences was as follows:

Chemistry	32	+5
Psychology	15	—3
Mathematics	13	+2
Botany	11	0
Zoology	11	—1
Physics	7	—4
Education	5	
Geology	5	—1
Sociology	5	4
Paleontology	4	+4
Astronomy	2	—1
Mineralogy	2	+2
Physiology	1	—3
Bacteriology	1	+1
Meteorology	1	+1

The second column, giving the increase or decrease as compared with last year, indicates that the sciences have in general maintained the same relative position. Chemistry leads so decidedly because in this science a university training is useful in technical work. The most disappointing aspect of university education seems to be the complete lack of medical students who take higher degrees. Here we have a field for research sure to yield results of the greatest possible theoretical and practical importance, and but very few trained workers. Physicians have opportunity, and in most cases leisure, but owing, it appears, to the lack of a proper education they accomplish comparatively little in the way of scientific research.

While no definite conclusion can be drawn from the results of a single year, it may be noted that at Johns Hopkins more than half the scientific degrees are given in chemistry. This science also leads at Yale and Harvard. Psychology and education are especially strong at Columbia. Chicago stands first in zoology and in physiology.

The details in regard to the theses are as follows:

Columbia University.

Burtis Burr Breese: Inhibition.

Edward Sandford Burgess: Studies in the Genus Aster.

Elsie Worthington Clews: The Educational Legislation and Administration of the Colonial Governments.

Henry Edward Crampton, Jr.: The Early History of the Egg in Molgula Manhattensis.

George Van Ness Dearborn : The Emotion of Joy.

Edwin Grant Dexter : Conduct and the Weather.

Elmer Wallace Firth : Micro-organisms in the Air of Public Buildings and Conveyances, due to Improper Methods of Cleaning.

Shepherd Ivory Franz : After-Images.

George Balthasar Germann : National Legislation concerning Education : Its Influence and Effect in the Public Land States East of the Mississippi.

Frederick Smith Hall : Sympathetic Strikes and Sympathetic Lockouts.

John Duer Irving : Some Eruptive Rocks of the Northern Black Hills and their associated Ore-bodies.

Smith Ely Jelliffe : The Flora of Long Island.

Edward Kasner : The Invariant Theory of the Inversion Group.

Walter Coluzzi Kretz : Positions and Proper Motions of the Principal Stars of the Cluster in Coma Berenices as deduced from Measurements of the Rutherfurd Photographs.

James Howard McGregor: Spermatogenesis in Amphiuma.

James Maclay : Double Minimal Surfaces whose Minimal Curves have Two Points on the Infinitely Distant Circle.

John Francis Woodhull : The Teaching of Physics in Secondary Schools.

Frederick John Pope : Investigation of Magnetic Iron Ores from Eastern Ontario.

George Albert Soper : The Purification of Drinking Water by the Use of Ozone.

Adna Ferrin Weber : The Growth of Cities in the Nineteenth Century.

Theodore Greely White : The Black River, Trenton, and Utica Formations in the Champlain Valley of New York and Vermont.

Harriet Winfield : The Oil of Maize.

Robert Sessions Woodworth : Psychology, The Accuracy of Voluntary Movement.

THE JOHNS HOPKINS UNIVERSITY.

Edward William Berger : Zoology, The Cubomedusæ, Physiological and Histological.

William Noland Berkeley : Chemistry, An Investigation of the Relative Rate of Reduction of Nitrobenzoic Acids.

Horace Greeley Byers: Chemistry, A Study of the Reduction of Permanganic Acid by Manganese Dioxide.

Joseph Scudder Chamberlain : Chemistry, A Further Study of two of the Products of Transformation of Parasulphaminebenzoic Acid when heated to 220°.

Francis Whittemore Cragin : Geology, The Paleontology of the Malone Jurassic Formation of Texas.

Oliver Lanard Fassig : Geology, March Weather in the United States, with special reference to the Middle Atlantic States : A Study of the Relations existing between Mean Atmospheric Pressure and the General Characteristics of the Weather and Storms in March.

George Stronach Fraps : Chemistry, The Composition of a Wood Oil.

Leonidas Chalmers Glenn : Geology, A Contribution to the Study of the Pelecypoda of the Miocene of Maryland.

Caswell Grave : Zoology, Ophiura Brevispina, Say.

Willis Boit Holmes : Chemistry, A Further Investigation of the Chlorides of Orthosulphobenzoic Acid and Paranitroorthosulphobenzoic Acid.

George Oscar James : Mathematics, On the Differential Equations connected with Hypersurfaces.

Joseph Francis Merrill : Physics, Influence of the surrounding Dielectric on the Conductivity of Copper Wires.

Rokuro Nakaseko : Chemistry, Some Transformations of Metasulphaminebenzoic Acid under the Influence of Heat.

Frederick Albert Saunders : Physics, A Bolometric Study of the Spectrum of an Absolutely Black Body between the Temperatures of 100° and 578° Centigrade.

Harold John Turner : Chemistry, Reaction of Sulphourea with Benzene- and Toluene-sulphon Chlorides.

Campbell Easter Waters : Chemistry, A Study of the Products formed by the Action of Heat on Parasulphaminemetatoluic Acid.

Francis Daniel Wilson : Chemistry, I. Orthosulphaminebenzoic Acid ; II. Orthocarbaminebenzenesulphonic Acid.

James Henry Curry Winston : Chemistry, Action of Tetrazoditolyl Chloride and Tetrazodiphenyl Chloride on Certain Alcohols.

YALE UNIVERSITY.

Lee DeForest: Reflection of Electric Waves of very high frequencies at the ends of Parallel Wires.

Alexander William Evans : The Hawaiian Jubuloideæ, a Tribe of Hepaticæ.

Arthur Woolsey Ewell : Rotatory Polarization of Light in Media subjected to Torsion.

Herbert Ernest Gregory : Geology of the Aroostock Volcanic Area of Maine.

Franke Stuart Havens : Analytical Separations by Hydrochloric Acid.

Holmes Condict Jackson : Some Observations on the Carbohydrates of the Liver.

William Smythe Johnson: Researches in Practice and Habit.

Louis Cleveland Jones: The Estimation of Boric Acid.

Edward Martin Kindle: The Devonian and Lower Carboniferous Faunas of Southern Indiana and Central Kentucky.

Albert Galloway Keller: A Sociological Study of the Iliad and the Odyssey.

Matataro Matsumoto: Researches on Acoustic Space.

William Conger Morgan: The Stereochemistry of Nitrogen.

William Huntington Parker: 1. A Study of the Alloxuric Bases, with especial reference to their Origin in the Intestine; 2. On the Maximum Production of Hippuric Acid in Rabbits.

Leona May Peirce: On Chain-Differentiants of a Ternary Quantic.

Charles Hyde Warren: Investigations in Mineralogy and Crystallography, including a Description of four new Minerals from Franklin, N. J.

CHICAGO UNIVERSITY.

Frank Burnett Dains: On the Isourea Ethers and other Derivatives of Ureas.

Emily Ray Gregory: Vertebrate Embryology.

Wesley Walker Norman: The Reaction of Lower Animals upon Injuries and the Theory of Pain Sensations.

Wilson Robert Smith: A Contribution to the Life History of Isoetes.

Aaron Louis Treadwell: The Cytogeny of Podarke.

Elizabeth Jefferies: On Methanes.

William Clark Gordon: The Social Idea of Tennyson as related to his Time.

Charles Abram Ellwood: Some Prolegomena to Social Psychology.

Henry Gordon Gale: On the Relation between Density and Index of Refractions in Gases.

Irving Hardesty: The Number and Arrangement of the Fibers forming the Spinal Nerves of the Frog.

John Anthony Miller: Concerning certain Elliptic Modular Functions of Square Rank.

Nels Lawrence T. Nelson: Revision of the North American Species of *Solanum*.

James Harvey Ransom: Molecular Rearrangement of O-Animophenol Derivatives.

UNIVERSITY OF PENNSYLVANIA.

Oliver Perry Cornman: Psychology, Spelling, a Psycho-pedagogical Study.

John Brookie Faught: Mathematics, Certain Development Coefficients analogous to Bernouilli's Numbers.

Paul Renno Heyl: Mathematics, The Theory of Light on the Hypothesis of a Fourth Dimension.

Joseph Hidy James: Chemistry, An Electrolytic Study of Benzoin and Benzil.

Lily Gavit Kollock: Chemistry, Electrolytic Determinations and Separations.

Charles Dickens Nason: Pedagogy, The Schools of the Society for the Propagation of Christian Knowledge among the Germans of Pennsylvania.

Richard Conrad Schiedt: Zoology, Some Phenomena of Pigmentation.

Alfred Tingle: Chemistry, The Influence of Substituents upon the Electric Conductivity of Benzoic Acid.

HARVARD UNIVERSITY.

Gregory Paul Baxter: Chemistry, A Revision of the Atomic Weight of Cobalt.

Edward Charles Jeffrey: Botany, The Development, Structure, and Affinities of the Genus Equisetum.

Gilbert Newton Lewis: Chemistry, A General Equation for Free Energy and Physico-Chemical Equilibrium, and its Application.

Arthur Henry Pierce: Psychology, The Localization of Sound.

John Percival Sylvester: Chemistry, Some Sulphuramido Derivatives of Furfuran.

Edwin Mead Wilcox: Botany, Contributions to the Knowledge of Dormancy in Plants.

Justus Watson Folsom: Zoology, Studies upon the Mouthparts of Apterygota.

CLARK UNIVERSITY.

James W. Boyce: Mathematics, On the Steinerian Curve.

Henry H. Goddard: Psychology, The Influence of Mind on Body.

Edmund B. Huey: Psychology, Physiology and Psychology of Reading.

George E. Partridge: Psychology, The Psychology of the Intoxication Impulse.

Henry D. Sheldon: Psychology, The History and Pedagogy of American Student Societies.

UNIVERSITY OF WISCONSIN.

A. T. Lincoln: Chemistry.

W. B. Lane: Psychology.

J. C. Shedd: Physics.

Theo. Running: Mathematics.

UNIVERSITY OF CALIFORNIA.

George Davis Louderback: On the Origin of the Glaucophane and associated Schists of the Coast Ranges. A contribution to the theory of the Crystalline Schists.

Winthrop John Van Leuven Osterhout: Observations on Spindle-formation and Chromosome-reduction in Plants.

Milicent Washburn Shinn: A Study of the Development of Sense Activity in the first three years of Childhood, with Pedagogical Conclusions.

UNIVERSITY OF MICHIGAN.

John Black Johnston: Zoology, The Structure of the Brain of Acipenser Rubicundus.

Paul Ingold Murrill: Chemistry, Halides and Perhalides of the Picolines.

Edwin DeBarr: Chemistry, The Decomposition of Alpha, Beta, and Gamma, Halogen-substituted Acids by Water.

PRINCETON UNIVERSITY.

William Foster, Jr.: Chemistry, The Conductivity and Dissociation of some Electrolytes.

Stanley Chester Reese: Astronomy, The Jupiter Perturbations of Minor Plant 367, with an ephemeris.

Alexander Hamilton Phillips: Mineralogy, The Geological and Mineralogical Characteristics of the Rocky Hill Trap.

BRYN MAWR COLLEGE.

Helen Dean King: Morphology, The Maturation and Fertilization of the egg of Bufo Lentiginosus.

Emilie Norton Martin: Mathematics; Determination of the Non-primitive Substitution Groups of Degree Fifteen and of the Primitive Substitution Groups of Degree Eighteen.

CORNELL UNIVERSITY.

Patrick Beveridge Kennedy: The Fruits of Grasses, with Reference to their Structure, Morphology and Taxonomy.

Darwin Abbot Morton: Anethol and its Isomers.

UNIVERSITY OF VIRGINIA.

Hillary L. Roberts: Mathematics, On the Geometry of a certain Group of Transformations.

John E. Williams: On the Geometry of a certain Group of Transformations.

WASHINGTON UNIVERSITY.

Hermann von Schrenk: Botany, A Disease of Taxodium known as Peckiness, also a Similar Disease of Libocedrus Decurrens.

Louis Herman Pammel: Botany, Anatomical Characters of the seeds of Leguminosæ, Chiefly Genera of Gray's Manual.

UNIVERSITY OF COLORADO.

Arthur John Fynn: Pedagogy, The Pueblo Indian as a Product of Environment.

UNIVERSITY OF MINNESOTA.

Alice J. Mott: The tenth year of a deaf child's life.

UNIVERSITY OF KANSAS.

Joshua W. Beede: Paleontology.

UNIVERSITY OF MISSOURI.

Chas. Thom: Botany, Morphology and Physiology of Reproductive Organs in the Archegoniatæ.

UNIVERSITY OF NEBRASKA.

Carl Christian Engberg: 1, The Cartesian Oval; 2, An Extension in the Theory of the Characteristics of Evolutes.

NEW YORK UNIVERSITY.

William C. Alpero: The Oils and Terpenes of Arabia Indicautis.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

IN a recent number of SCIENCE, Professor Carus has presented most serious objections to the bibliographical methods proposed by the Royal Society's Committee. For the professional zoologist such a verdict needs no criticism. For no one else can possibly claim to have such a wealth of experience at his disposal as this Nestor of scientific bibliography.

Severe as the criticisms of Professor Carus are, they may be supplemented by others which will make the case against the proposed schedules still stronger. Book bibliographies may entirely dispense with arbitrary symbols; the real test of a numerical system is to be sought in the application of the system to cards. Since I have been the pioneer in the publication of an extensive card catalogue of scientific literature, it was natural that the editors of SCIENCE should invite me to express in their columns a judgment upon the new proposals; but my criticisms, if frankly expressed, would have to be so severe that I was loath to take a position which would seem to place me in opposition to an enterprise to which I had already pledged allegiance. I feel, however, that I cannot withhold the following statement:

No one without extensive experience can possibly foresee the complications that arise

in practice; nor can the matter be easily explained. A simple statement may, however, serve as an illustration. Thus far the Concilium Bibliographicum has issued more than 3,000,000 cards. During the past year we made a trifling modification in the typography, which surely passed unnoticed by nearly all our subscribers. This discovery leads to a minute saving on each card, but in view of the enormous number of cards the saving is great enough to modify considerably the balance sheet.

I have given the schedules proposed by the Royal Society's Committee a fair trial, with more than 3,000 different zoological cards. Indeed, I have worked so much with this classification that I once knew it quite by heart. It is my firm conviction that our organization would have long since failed utterly had we been obliged to use it for our work. It is also significant that the faults of the new schedules are merely exaggerations of those that I should have made when I first began working out the details of our own undertaking. I have recently passed in review some of my own notes, dating from February, 1894, and I am surprised to see there the same insufficiencies in what I then considered a completely adequate plan.

It is difficult to criticise, in the definite way that one would desire, a work which probably scarcely a dozen of the readers of SCIENCE can ever have seen. For this reason I shall refer rather to a Memorandum published by the Committee subsequent to Professor Carus's article, and which is intended to justify the course followed. In one respect this Memorandum resembles its predecessors in a way that is most regrettable. It is that of ignoring all that others have done or said in regard to the matter under consideration. Professor Carus had brought direct, definite and undeniable charges of insufficiency against the schedules of the Committee. Not one of these charges has been answered nor even alluded to. Surely this refusal to accept debate and the avoidance of publicity cannot be indefinitely maintained. The scientific world has the right to know why no account is to be taken of the opinions of those best qualified to judge of the merits of the case.

The methods of those who use the decimal system are condemned in this Memorandum with a few words, which I shall transcribe: "The Committee prefers to designate the sciences by letters rather than by numbers." In my opinion, this is a small matter; it is a mere matter of convention, like signals at sea. Uniformity alone is essential. The Concilium Bibliographicum will soon have 5,000,000 cards where a number is used for this purpose; this number is the same that is used for the same division in all libraries using the decimal system; it also corresponds with the numbers used for 2,500,000 different cards in Brussels, and with a larger collection in Paris. Such use has been advocated by the French Association for the Advancement of Science, by the Société de Biologie, by the Société Zoologique, by the corresponding Swiss organizations and by numerous Italian and Belgian societies. Indeed, the Decimal Classification has had a marvellous development. Unknown in Europe a few years ago, it has spread over the whole of Europe; it has been carried to Australia and to South America; indeed, I recently heard of an application that was being made of it in Japan and another in Hawaii. It has not, of course, yet gained the confidence of the majority of bibliographers. That would be too much to expect of it, but we may be assured that a short experience with *cards* would convince even those now opposed. In the future, if the will of the Committee prevails, two systems will struggle for mastery. The new symbols can only be introduced by destroying the accord that has already been attained. In a word, in 'preferring' to

use letters rather than numbers, the Committee calls upon the scientific world to aid it in crushing out the work that has already been done. For this it must have weighty reasons, or it would be wrong for any government to favor such action.

The Committee writes: "As between a letter and a number no single final reason can be alleged, but there are a number of considerations which led the Committee to prefer the letter. In the first place, the Committee divided Science into more than two principal parts, and the tendency of the recent Conference was to add to the number of divisions. Hence a decimal system is inapplicable to the Primary Divisions, unless by grouping together several of the Principal Divisions under one or more heads. Science is arbitrarily made to fit a system which does not naturally fit it. In the second place, it is convenient to have a single symbol for each Principal Science, whereas, if numbers were employed, two figures would be required, owing to the number of divisions. Lastly, the Committee believe that fewer mistakes would be made in sorting the slips and cards if attention had to be paid to a letter and number rather than to a single but longer number. On the whole, then, the Committee, decided to represent the Principal Sciences by arbitrary letters."

These are the arguments, but I refuse to believe that it will be generally felt that they justify the work of destruction which is proposed. But even the little weight these arguments may seem to have disappears when they are closely examined. The letters required for the sciences thus far selected for treatment run from A to R, thus permitting for the time being, it is true, the use of a single symbol; but it is evident that this is possible simply because the proposed catalogue is to contain only certain sciences. Professor Carus has already pointed out the dangers of thus disregarding a general system of notation compatible with the adjunction of new branches. With the addition of a few subjects, the 26 letters of the alphabet will be exhausted, just as the ten digits would be. This eventuality destroys the whole value of the first two arguments. The difficulty contemplated in the third argument has long since been met in the Concilium Bibliographicum by separating the two figures indicating a Principal Science from those representing sub-divisions of that science, and by printing these figures by themselves as 'the signature' of the set. The sample card given below will illustrate this feature.

This is the entire argument relating to the Principal Sciences. For the subdivisions of a science the Committee proposed the use of numbers, but preferred other numbers than those already employed. "As to the system by which these numbers should be chosen, the Committee had before them the deliberate decision of the Conference of 1896, that the Conference was 'unable to accept any of the systems of classification recently proposed,' among which the decimal system was, of course, included. This system had, therefore, not been accepted, and the Committee agreed, after further discussion, that it was not desirable again in any way to propose a decimal system. Such a system is open to two objections. In the first place, it assumes that each subject is to be divided into not more than ten divisions, each of which may be divided into not more than ten, and so on. This arbitrary use of the number ten is in practice extremely inconvenient, since it has no relation to the rational divisions of the sciences; and, in so far as it assumes that the subjects indicated by the figures in a certain place of decimals are subordinate to those which occur in a higher place, it involves theoretical considerations, the validity of which may not in all cases be admitted in the future. In the second

place, the decimal system is quite inapplicable to sciences which need a double system of registration, such as Geology (in which reference has to be made both to the order of the strata and to their geographical distribution), Geography, Zoology and Botany."

about is dealt with under 242, or whatever the number may be, and under that number he finds the desired cards. When I turn to a time-table to learn when a train leaves I do not need to study out why that train leaves when it does rather than ten minutes later or earlier. The time-table satisfies me

Warren, Ernest. **78 Rana** : 12.14

1898. An Abnormality in *Rana temporaria.* **Anat. Anz. Bd. 14 p. 551—552, 1** fig. [Vascular connection between rectal vein of hepatic portal and apex of the lung.]

In Bibliographia Universali —**59** edidit Concilium Bibliographicum.

Typographia Concilii Bibliographi

Specimen Card of the Concilium Bibliographicum.

The first of these objections seems again insufficient to justify the destructive and revolutionary measures proposed. On critical examination, indeed, it proves itself utterly groundless, being based upon a complete misconception of the decimal system as applied to a purely practical problem. This system does not attempt to force science into an artificial mould. It merely assigns an arbitrary number to each topic, so that the cards, when arranged according to these numbers, fall into their proper places. These numbers are so chosen that the framers of the system can expand it *ad libitum*, without ever altering the signification of the numbers previously used. How this latter feature can be reached the user of the catalogue does not need to know. He merely finds in the key that the topic he desires information

if I can find out when my train leaves. So it is with the Decimal System; one word of frank criticism, one single instance in which by its use one would be prevented from finding the answer to a question of bibliography would have more value than these theoretical considerations of coordination and subordination, which have nothing to do with the case. The best proof, however, that the Committee's argument is not serious is the fact that in framing the new schedules, in spite of the entire freedom of action that was enjoyed, the Committee involuntarily built up a decimal system, a new one, for all sciences save Chemistry and Mathematics, and even here the deviations from a decimal arrangement are not greater than Dewey himself allows. A new decimal system has been created, the numbers being

lengthened to four places, so as to remove the outward form of a decimal system; but, from want of experience in such matters, numerous pitfalls have not been avoided.

The second objection contained in the Committee's statements is one of extreme gravity; but it is a mere assertion, which a single glance at the Bibliography of the Concilium Bibliographicum would show to be utterly false. The Committee asserts that the decimal system is 'quite inapplicable' to sciences which need a double system of registration, such as Geology, Zoology, etc. It is well known, however, that the system is being applied to Zoology by Professor Carus, by myself and by others with entire success. Indeed, were I to select a single feature to show the paramount superiority of the decimal system it would be this facility of double registration. The Swiss Zoological Society voted warm approval of this method. The Executive Committee of the Swiss Society, corresponding to the British and American Associations for the Advancement of Science, was convened to a special session for the sole purpose of arriving at a definite conclusion as to the merits of this system. The Committee examined carefully the work of the Concilium Bibliographicum and pronounced the system vastly superior to that proposed by the Royal Society, and petitioned the federal government to oppose the proposed modification. A technical commission consulted by the federal authorities expressed the same opinion, as did also the Swiss Library Committee and the delegates appointed to attend the London Conference. This all took place after the government felt that it was committed to supporting the scheme of the Royal Society. Finally, a last conference was held under the presidency of the Minister of Interior and voted unanimously to make the adhesion of Switzerland absolutely dependent upon the decimal system being adopted. Such testimony from those who know the working of the system best is surely worth more than a simple assertion to the contrary by persons who evidently do not know the system condemned. Not merely is there abundant internal evidence that the statements made by the Committee must have been made in ignorance of the methods which it so severely condemns, but it can be proved by the books of the Concilium that they could not have studied the matter by examining our cards. Not merely has the Royal Society never subscribed to the cards issued by the Concilium, but there is only a single subscriber in all England who receives a set of cards sufficiently complete for it to be regarded as a fair sample. This subscriber has written that he is greatly impressed with the success of the methods followed by the Concilium, especially in the matter of the double system of registration. He states that the cards have never been examined by anyone connected with the Royal Society's undertaking. There is evidence, therefore, that this condemnation has been passed without knowledge of the thing condemned, for a final judgment with regard to the merits of such a bibliographical system cannot be reached, save by knowing it in its application to cards

Having met all the objections raised against the decimal system, I shall now say a word on the system which is proposed to replace it. Having, as already stated, tried this latter on several thousand cards, I can state, without fear of contradiction, that it fails utterly, as far at least as Zoology is concerned.

The zoological schedule proposed by the Royal Societies comprises two distinct parts, each designated by 2 figures. One part consists of what we should term the systematic classification and comprises 33 heads designated by the series of even numbers from 2 (or 02, as this is written, so as always to have two figures) to 66. The other

part, or topical classification, comprises 9 heads designated by odd numbers extending from 3 (or 03) to 35, the numbers 05, 09, 13, 17, 21, 15, 29 and 33 being left vacant. The entire symbol consists of four figures, the first two being taken from the systematic, the latter two from the topical classification.

The Committee states: "The numbers used to designate the subjects are scattered over a series extending from 203 [0,203] to 6,635 in such a way that any branch or any subject may be in future completely divided and numbers applied to the divisions without deranging the system previously in use." This statement shows clearly that the Committee not merely has failed to study the decimal system, which they condemn; but has not even examined critically their own system; for I believe that every attentive reader has already detected, in the course of my brief exposition, that no modifications nor interpolations are possible, for the simple reason that all the numbers are occupied. There are, it is true, eight vacant numbers, but these are, indeed, 'scattered,' so that no new sub-divisions can be introduced, for at least 2 places are needed to sub-divide. How necessary new divisions are may be gathered from the fact that one single division 0,407 would receive according to our experience, about 2,000 cards, annually. In ten years there would be twenty Library Bureau drawers filled with cards, all with the some identical symbol. No one, of course, consults a bibliography to know what has been published in regard to the Morphology of Vertebrates; he wishes to know what has appeared on the liver, the teeth, the skull; he desires information regarding Sphingidæ, not a rambling list of 8,000 papers on Lepidoptera (in 10 years there would be 8,000). We have at present on stock 400,000 cards dealing with Morphology (which is not sub-divided by the committee); several times a day we have occasion to seek out a relatively small number of cards from this great collection. Thus, if anyone desires to receive the cards relating to the liver 14 cards would be gathered together for him and he would be charged 14 cents, including postage and packing. The entire internal organization of the Bureau depends upon a precision of registration, such as an outsider can scarcely conceive to be necessary. Constantly one has to turn to the stock to replace a torn or soiled card, to return a duplicate to its place, or for some similar operation. Were we to try to use the Royal Society's schedules we should have to double our staff, and should even then live in a state of confusion that would be intolerable.

It seems astounding that the Committee should propose a system which admits of no modification, since Professor Armstrong stated at the first Conference that the "whole question resolves itself into whether we can adopt an inelastic system." But never was a system so inelastic as that proposed by the Committee. The Dewey System, the Cutter System and the Halle System may all be regarded as rivals. That of the Royal Society has not attained to this eminence, for it cannot claim to have even attempted to solve the initial problem, that of combining permanence with expansibility. Indeed, the Committee seriously proposes that their system might be revised and modified at intervals of five years! So far, then, from the great problem having been solved, it has not been even discovered what the nature of the problem is.

Quite as important as expansibility is the quality of *adaptability to special needs.* We have seen that the new schedules require that the systematic portion of the symbol should always be placed first. In other words, the symbols can not be adapted to the needs of those who wish to use topical divisions as their primary classification.

Thus a person interested in Cytology would be obliged to seek through all the groups of animals from Protozoa to Mammals in order to find the cards that he would require. It would have been extremely easy, with a little experience, to have arranged the *same divisions* so that the immense advantage which the Decimal System presents in this regard could have been obtained for the new schedules; but, here again, the Committee failed to grasp the problem, and consequently made no attempt to solve it. Nearly one-fourth of our subscribers require an arrangement which the Royal Society's schedules cannot give them. This is only one, however, of the special adaptations possible with the Decimal System. At present we have 7 such arrangements, each of which corresponds to certain definite needs. It is a significant fact that our arrangement, corresponding most closely to that absolutely prescribed by the Royal Society's schedules, has been offered for sale for two years and has found no subscribers.

Of course, a prime necessity in such a system of classification is that there should be a *place for everything.* It is also one of the most difficult features to attain. In elaborating the system employed in the Concilium Bibliographicum months were entirely devoted to studying the topics dealt with in the publications of a period of ten years, so as to properly proportion the divisions to the rate of publication and, above all, to be sure that no important topic was omitted. The after-trial showed that this had been done so successfully that there was little to add, the only serious omission being 'phosphorescence,' and this omission was due to an error in copying. A certain number of unusual topics do, indeed, appear each year which it is difficult to classify, as, for example, Ebner's papers on the electrical qualities of hair and feathers. On the other hand, scarcely a week passes when we do not meet with a dozen papers that the new schedules could not cope with, save, perhaps, by frequent repetition. What, for example, could be done with a lecture on Scientific Methods? Where would one classify a paper on the Advance of Natural Science during the Victorian Era? There is no place for Sir. Wm. Flower's book on museums, or rather there are many places for it. Then the science of microscopy with special text-books, with special journals, has no place assigned to it either as a primary science or as an aid to such sciences as Zoology or Botany.

In the choice of divisions the Committee has been not less unfortunate. For instance, there is a general division Arthropoda, but none for insects. A preliminary statistical study would have revealed to the framers of the tables that for every 20 papers appropriately placed under Arthropoda there are about 375 which deal exclusively with insects in general. One further instance may suffice. The Concilium Bibliographicum has experienced great difficulty with one of its divisions, namely, 07. This division, which is used for Museums, Laboratories, Stations, Technical Methods and Methods of Study, proves in practice utterly unwieldy. The diversity of these topics makes the search for a trifling matter a work of great labor. We had just begun to realize this when criticisms began coming in from our subscribers stating that they, too, found this group unwieldy. It was with interest, then, that I turned to the new schedules to see how the matter had there been treated. Far, however, from breaking up this division, the new schedules add to the diversified topics already mentioned the following special text-books and manuals: Relations to Plants; Injurious Animals; Special Products, Wax, Silk, Honey; Bibliographical, including Historical, Biographical. Could anything be less practical than this? It is, of course, no answer to state that it is proposed to use the system of

significant or predominant words for purposes of more minute sub-division. The Committee surely does not suppose that the sorting clerks and the libraries arranging the cards can attain, by significant words, a logical arrangement of the matter, such as is shown on the next to the last page of the zoological schedules, involving, as it does, the knowledge that the 'retina' goes with the sense organs, while 'Ears of Man and other Primaries' is a mere question of external facial morphology. The new system would, as we have seen, require a much larger staff of employees than would be necessary with the decimal system; this peculiar use of catch-words would make it, furthermore, necessary to employ trained zoologists for mere mechanical sorting. Moreover, I venture to state that the Committee would be astounded with the results of the simple experiment of classifying a few thousand cards, as proposed in the introduction to the zoological schedules. This matter is extremely difficult to explain in words, but the experiment is most convincing. It would be found notably that there would be a conflict between the systematic and the topical catch-words and that the bibliography would be rendered useless for a vast number of questions that it might otherwise answer.

Uniformity is regarded as no virtue by the Committee. This again proves how impossible it is for one to form a just *a priori* conception of the actual work in a Bureau publishing a card bibliography. In the tables of the Concilium, Embryology is treated somewhat differently in the zoological and in the anatomical bibliographies. This error was committed before the full value of uniformity had been grasped. It has proved to be a persistent source of confusion and delay. Indeed, such misconceptions abound in the report of the Committee. To cite one further example, the Committee speaks incidentally of sorting the cards into pigeon holes, as in a post-office. I, too, once believed that to be possible and blundered for many months before devising the multiple check system, which at once precludes errors of sorting and more than doubles the rapidity of the work.

It is not my purpose to discuss matters of *organization* in detail, but there are certain decisions in this regard that could not be passed over in silence. Regional bureaux organized by various countries are to prepare the manuscript, which is to be finally edited in London. Now a decision of the Congress says that the text, and not the titles, of the papers is to form the basis of classification. Therefore, one of two things must occur: Either the regional bureaux must maintain a fully competent staff of specialists, and themselves attend to the classifying, or the specialists in London must consult the works a second time, thus rendering the operations of the regional bureaus useless. The Concilium Bibliographicum follows strictly this principle of classifying according to the text and not to the title. I could cite papers which took many hours to classify, and numerous zoologists can bear evidence that we have not hesitated in cases of doubt to write to them personally before publishing. To show the constant difficulties, let me mention a few cases that have occurred *in the past week*: Firstly, we have had three papers describing new species, in which the fact that they were new could only be ascertained by the context, and one in which the symbol n. sp. was appended to a species already described elsewhere by the same author. Secondly, there is a paper by Alcock and Henderson, published in the *Annals and Magazine of Natural History* (7) Vol. 3, p. 1–27. In this paper 92 species are mentioned, of which 31 are new *and provided with new specific names.* There are, however, only 21 descriptions given. It is, furthermore, stated

that the figures will be given in connection with a work to be published, we believe, in India. Of all these facts memoranda were taken and a careful outlook was kept till this week, when an unexpected continuation appeared in the *Annals and Magazine* for April, where the remaining ten pieces were described three months after the first paper. We have still memoranda filed under the author's name and under publications arriving from India, so that the figures may be referred to in connection with the descriptions, and have written to the authors for more precise data. A third instance is in the last volume of the Mémoires of the Société Paléontologique Suisse. Here the new species are distinguished by the addition of the year 1898 to the author's name. In this case I do not believe an inexperienced person could discover that they were new species. Finally, in the last number of the Proceedings of the Zoological Society of of London, p. 586, is the description of a new species of monkey, contained in a statement of the additions to the menagerie. These are but a few instances taken from the proof-sheets now before me. Were I to go further back I might mention utterly confusing cases, such as the paper by Schuchert in the Proceedings of the United States National Museum, No. 1117, where the context shows that the new species described as *Dipeltis Carri* is really *Diplodiscus Carri*. Does the Royal Society really suppose that a reliable work can be framed, dependent upon the contributions of a score or more of workers scattered all over the globe? Does it suppose that all these countries will maintain a staff of trained specialists to do this work? In such work it is of prime importance that the work should be centralized ; any other course is extravagant, leads to inaccuracies and confusion, and tends to delay the publication.

Turning, now, to the central bureau in London, let me point out a suggestive contrast: The Committee believe that, on the average, the experts editing the bibliography of each science will have about three or four hours' work per week. In the Concilium, although the experts lose almost no time for mechanically copying titles (this being done for them), it is found necessary to devote about 68 hours to this work. This does not include the time of the proof-reader.

The financial statement is also open to criticism. In the first place, it is to be noted that the estimates are based upon the use of the linotype, while all the examples involve ordinary type-setting. With the linotype only one kind of type can be used. In order to obtain a differential card, such as the Concilium issues, no less than six kinds of type, not to mention the Russian, Polish, Bohemian, Spanish, Hungarian, Scandanavian and Portuguese alphabets, which must frequently be drawn upon. Considering, now, the specimen set of slips, I may call attention to the fact that, according to the tariff in use on the Continent, at least, the type-setting would cost 35 per cent. more than it would according to our usages ; the missing pages could not be estimated by the tariff, but the most favorable calculation for the Royal Society would make the expense three times as great as ours. When we turn, however, to the preparation of the secondary slips the expense becomes at least twelve times greater than that incurred by the Concilium. These facts are particularly significant, since the additional expense is primarily due to the non-adoption of the decimal system. That the sorting is thereby rendered much more expensive I have already shown. Finally, Professor Carus has pointed out the fact that the financial statement is based upon a great underestimate of the number of titles published. For Zoology the number should be tripled. The greatest discrepancy is to be found, however, in the estimated sale of the catalogue. For the authors' catalogue the Com-

mittee states that even under the most favorable circumstances 130 subscribers would be needed. The Concilium has seven subscribers to its authors' catalogue. Can it be that the Royal Society will be nearly twenty times as successful? For the 'complete catalogue' the Royal Society must find 286 subscribers. The Concilium has 18; but the price of its complete set is only about one-third that proposed by the Royal Society for the corresponding cards, and the bulk corresponding less. How many institutions will care to receive 90 or more cards a day, knowing that the entire expense will not fall far short of $500 a year?

To summarize, then, the project of the Royal Society can be shown to be utterly impractical, whether viewed from the technical side or from that of its finances. It has been elaborated by distinguished scientists, who have made the primordial error of supposing that experience was superfluous in dealing with such problems. It is a natural error to have made. It is one which I once also made without having the excuse of scientific eminence. I can frankly confess that 5 years ago my ideas on this subject were utterly immature and that it was my inexperience that made the first years of our work so unsuccessful. The Royal Society schedules might, of course, be applied to a book bibliography. Most of the objections which I have made would not exist, but *for the special needs of a card bibliography the zoological part is a complete failure and many other parts inspire grave objections.*

The most serious aspect of the case remains yet to be considered. The new enterprise is being organized without any consideration being taken of existing work. To succeed, the Royal Society must destroy all that exists, and it asks for a guarantee fund of $200,000, in addition to an annual expenditure in individual countries, which has been estimated at $20,000 as a minimum. The Committee, however, states that the work is to be regarded as an experiment and should be abandoned unless it should prove self-supporting. It will be evident to any one who has read attentively this note that the work can not be self-supporting if conducted as contemplated, and if given up nothing but devastation will have resulted from the action of the Royal Society. It was this perspective that caused Professor Carus to express the fervent wish that science might be spared this calamity.

Under such circumstances one may well ask one's self what should be the attitude of the Concilium Bibliographicum, which has been built up through thoroughgoing self-sacrifice. It was after the preparations for its foundation had been largely completed that the intentions of the Royal Society were first made known. Concerned lest the task that I had undertaken might be robbed of its utility by this greater enterprise, I applied for further information. No definite answer could be given, save the assurance that it was intended "to make use of all fitting existing institutions, certainly not to rival them." This answer was, however, regarded as sufficient by myself and my advisors, and it was decided to continue the work. Later a subsidy was granted to us with the distinct understanding that our mission was to be that of solving the technical difficulties involved in a great scientific card bibliography, and of forming a nucleus for the larger organization. It was thus that in our prospectus we freely pledged allegiance to the Royal Society's project, and our course has been uniformly directed to this end. To-day the conditions are strangely changed. The promoters of the new bibliography did not subscribe to the cards, nor has the slightest attempt been made to profit by our experience. The Concilium Bibliographicum has not been consulted regarding a single decision that has been taken. Indeed, the existence of an organization publishing one-third the

number of cards contemplated was not even alluded to in the Conferences, while the methods that have given such strikingly successful results have been condemned without consideration. In their place, methods similar to those which the Concilium tried and discarded are now proposed, and plans are elaborated that forebode a complete catastrophe. In the meantime, other organizations have tried methods similar to our own and have reached valuable results. So much has been done, indeed, and so much money and labor have been expended, that an abandonment of the work is out of the question. If the new bibliography rejects these methods there is no other course possible than for the governments that have been convinced of the value of these methods to maintain a second parallel bibliography. The decision of the Conference, held under the presidency of the Swiss Minister of Interior, is clear in this regard: It makes the participation of Switzerland definitely dependent upon the acceptation of these tried methods, and gives the government freedom of action in case its conditions are not accepted. For my part, I feel that I should belie the entire character of our enterprise were I to hold aloof from the Royal Society from motives of personal interest. But it seems equally certain that I should betray the trust that was given to me were I to consent, through motives of personal interest, to render useless the work which has been so zealously built up. We owe it to the world that the work of five years should not be labor in vain.

But what necessity exists for such drastic measures? We are still ready to rally under the banner of the Royal Society. The only condition is one that will preserve the Royal Society's undertaking from catastrophe.

HERBERT HAVILAND FIELD.

ZURICH.

*THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

I NEED hardly remind you that the Australasian Association held its first meeting in Sidney, from 27th August to 5th September, of the Centennial year, 1888, under the presidency of Mr. H. C. Russell, C.M.G., F.R.S., with a roll of 850 full members. Meetings have since been held in Melbourne in 1890, with 1,162 full members, when the late Baron von Mueller, K.C.M.G., F.R.S., M.D. and Ph.D., was President; at Christchurch, N. Z., in 1891—President, Sir James Hector, K.C.M.G., M.D., F.R.S.; at Hobart, in 1892—President, His Excellency Sir Robert Hamilton, K.C.B., LL.D.; at Adelaide, in 1893—President, Professor Ralph Tate, F.G.S., F.L.S.; and at Brisbane, in 1895, when the Hon. A. C. Gregory, C.M.G., M.L.C., F.R.G.S., was President.

The government of New South Wales provided for the printing of the first volume, and the governments of Victoria, Tasmania, New Zealand, South Australia and Queensland have each in turn given liberal assistance, both by money grants and in other ways towards the expenses of the session, and by printing the volume of reports and papers.

The Association has up to the present published 6 volumes of reports, each of about 1,000 pages, containing much important matter; it has appointed committees for the investigation of the following subjects; all have furnished reports, which, being of permanent value, have been printed, viz:

1. The Establishment and Endowment of a Biological Station for Australasia.
2. Certain points in the Construction and Hygienic Requirements of Places of Amusement in Sydney.
3. A Census of Australasian Minerals.
4. Glacial Evidence in Australasia, £20 granted towards the expenses.

* From the address of the President at the Seventh Meeting, held at Sydney, 1898.

5. Town Sanitation.

6. The Seismological Phenomena of Australasia, (£10 granted in aid of this research).

7. A Bibliography of the Australasian and Polynesian Races.

8. The Question of Antarctic Exploration.

9. The State and Progress of Chemical Science in Australia, with special reference to Gold and Silver Saving Appliances.

10. The Question of Rust in Wheat.

11. The Location and Laying-out of Towns.

12. The Improvement of Museums as a means of Popular Education.

13. The Fertilization of the Fig in the Australasian Colonies.

14. The Unification of Colors and Signs of Geological Maps.

15. The Tides of Australia (The Tides of the coast of South Australia).

16. Polynesian Bibliography, with special reference to Philology.

17. The Protection of Native Animals.

18. Glacial Action in Australasia during Tertiary and Post-tertiary Eras.

19. The Photographing of Geological Surveys.

20. The best means of encouraging Psychophysical and Psychometrical Investigation in Australia.

It has also granted the sum of £25 towards the ascertainment of movements of New Zealand glaciers, and £10 towards the cost of the erection at Timaru of the seismological instruments, presented by Dr. Von Rebeur-Paschwitz. It has secured (1) from the New Zealand Government the reservation of the Little Barrier Island, and Resolution Island, Dusky Sound, as suitable localities for the preservation of native flora and fauna. (2) In response to a recommendation from the 1891 session, it was agreed by the Lords of the Admiralty, that the sea between New Zealand, and the islands to the northwest of New Zealand, on the one hand, and Australia and Tasmania, on the other, be known as the Tasman Sea, and that the name is to be entered on the Admiralty charts. (3) Further, through the instrumentality of the Association, the New Zealand Government has set apart Stephen's Island, Cook Strait, as a reserve for the Tuatara Lizard, and (4) Correspondence has been received from the Governments of Tasmania, New South Wales, New Zealand and Victoria, in which sympathetic acknowledgment is expressed towards the wishes of the Association in regard to resolutions, passed at its last Session (in Brisbane), viz., to bring before the Australasian Governments that it is desirable:

a. That a system of compulsory notice of infectious diseases be introduced.

b. That a system of federal quarantine be introduced.

c. That stock, the milk or flesh of which is intended for consumption, be examined by duly qualified men, and slaughtered, if found tuberculous or cancerous.

At the last session (Brisbane, 1895) a number of research committees were appointed, some of which will report during the present session. Chief among these may be mentioned:

1. For the investigation of Glacial Deposits. (Reappointed.)

2. The Seismological Committee, to investigate earthquake phenomena in Australasia. (Reappointed.)

3. To consider and report upon the Thermo-dynamics of the Voltaic Cell.

4. The geology, land flora, land fauna, and natural resources of the islands and islets of the Great Barrier Reef.

5. The habits of the teredo, and the best means of preserving timber or structures subject to the action of tidal waters.

6. The Committee to give effect to the suggestions contained in Sir Samuel Griffith's paper entitled 'A Plea for the Study of the Unconscious Vital Processes in the Life of a Community.'

AUSTRALIAN BENEFACTIONS TO SCIENCE.

In connection with the efforts made for the advancement of science in Australia we should not overlook the recent generous gift made by Mr. P. N. Russell of £50,000 for the support of our Engineering School, for instruction in pure and applied science. This is, perhaps, one of the best ways of supporting the objects of this Association, *i. e.*, by providing a scientific training for

students, who may develop into men of science.

Then there is the bequest made by Sir Thos. Elder to the Adelaide University, of which a large portion goes to support the mining and other scientific schools.

Also the scientific expedition to Central Australia, which was despatched by Mr. Horn from Adelaide at great expense. We shall have the pleasure of hearing of some of the results of this act of public-spirited generosity from Professor Spencer, who is kindly giving our members a lecture upon Central Australia.

Next there is the expedition from the Royal Society of London, under Professor Sollas, to investigate the structure of a coral reef by boring, to which this colony contributed liberally in men, money and material.

During the past year this has been supplemented by another expedition from Sydney under the charge of Professor David, largely at the cost of residents in this colony and the new South Wales Government. The Royal Society of London has again provided a large portion of the requisite funds.

I do not propose to go into the matter, as I have no doubt a full report will, in due course, be issued by Professor David; meanwhile, I think we should express our pleasure at the safe return of the expedition and our gratification at the success which has so far been achieved, especially as the operations had to be carried out under considerable difficulties.

PROVINCIAL SCIENTIFIC SOCIETIES AND INSTITUTIONS.

Outside the capital of New South Wales scientific societies and institutions are practically non-existent, and I think this is also the case with respect to the other colonies of Australasia, except New Zealand.

New Zealand sets Australia a good example, for although its population is only about one-half that of New South Wales, it has comparatively large and active scientific societies in Auckland, Christchurch, Dunedin, Napier, Nelson, Wellington and Westland. All of these are separate and independent societies, but collectively they form the New Zealand Institute, centered in Wellington. Papers read before the local societies, if of sufficient merit and importance, are published in the Transactions of the New Zealand Institute; this is an exceptionally wise plan, for the smaller societies could not afford the expense of publishing separate annual volumes; further, the papers are distributed more widely and a better standard can be maintained. If there were similar local societies in Bathurst, Broken Hill, Goulburn, Newcastle, and other towns in New South Wales, which are quite as large as some of the New Zealand towns, they could do much for the advancement of science, and assist the aims and objects of this Association.

I have spoken more particularly of this Colony, but of course the remarks also apply to the larger towns of the other colonies, where there are no local societies. Such societies could probably, if they existed and so wished, be affiliated to the Royal Society of New South Wales or of Victoria, South Australia or Queensland, and to this Association. The British Association has a system of corresponding societies, who send delegates to its meetings.

It is a very great pity that such societies do not exist in our provinces, not only for the benefit of the local residents but also for the cause of science generally.

At present this Association has to depend very largely upon the members of the staffs of the universities, observatories, museums, the geological surveys and certain other government departments, and most of these, with the exception of those resident in the

capital in which the session is held, have to undertake a journey of 500 or 600 miles, or even 1,200 miles, as in the case of those who attend from New Zealand, or who, living in Brisbane, attend a meeting in Adelaide, or *vice versa.*

These very long distances are a great disadvantage to the Association, for they mean a considerable expenditure of time and money, and many are thereby debarred from attending. It is largely due to these causes, as well as to the limited number of working members, that we have had most reluctantly to substitute biennial for annual sessions. If we had more working members, and I think we should get them if there were local scientific societies scattered through the Colonies, we should be able to resume our annual meetings, and before very long we ought to be able to hold our sessions in towns like Ballaarat, Bathurst, Bendigo, Goulburn and Newcastle.

For the formation of local societies it is not necessary to start with a large membership—the Royal Society of London began with five or six only.

It is, however, very gratifying, under the circumstances, and with our comparatively limited population, that our meetings are as well attended and successful as they are.

A. Liversidge.

THE RED COLOR OF THE SALT LAKES IN THE WADI NATROUN.

In an article published in the *Zoolog. Anzeiger** I have given a report on the biology of the Natron Valley, the Wadi Natroun, in the Libyan desert, about 170 kilometers from Cairo. It seems that my remarks concerning the red color of the water of the salt lakes of the valley have interested readers of the article. I, therefore, wish to add here some researches I was able to make on the same subject owing to the kindness of Mr. Prochaska, head of the chemical survey of the soda company.

* Das Wadi Natroun in der libÿschen Wüste und seine niedern Thiere. Bd. 22, p. 53–61, 1899.

When I came to the Natron Valley the red water of the lakes excited at once my curiosity, and I tried to ascertain the reason for the redness of the liquid. Most people to whom I spoke about the matter told me that *Artemia* lives in the lakes, and that the red color of this Crustacean is communicated to the water. During my stay in the Wadi the *Artemia salina* was not to be seen, the animal appearing only at certain periods of the year. It is impossible to believe that the colored mass of these small creatures is sufficient to stain such immense quantities of water as the Wadi Natroun lakes. These lakes, about fourteen in number, lie rather close to each other and extend over a space of about 40 kilometers. No number of *Artemia salina* would be great enough to give the water the deep purple color which it has. If there were frogs in the lakes and those frogs were red, and some one should say that the red color of the water came from the red color of the Amphibia, this explanation, I think, would not be much inferior to the *Artemia* theory. Besides *Artemia* there are other red animals in the lakes. I obtained, for example, a red culicid larva. This shows that animals living in the water may take the color from it, and not the water from the red animals. Finally, *Artemia salina* disappears in the lakes for the greater part of the year without causing a change in the coloration of the water.

But, if it is not *Artemia salina*, what is it that gives the red color to the water? In my investigations I treated the red water with different chemicals, among them acetic acid. When the acid is poured into the red water a powerful development of carbonic acid takes place, and at the same time a red soft mass rises to the surface of the liquid, while the latter loses more and more of its color. From a large quantity of

water I collected the soft red mass swimming on the surface, washed it with distilled water and shook it in a mixture of ether and absolute alcohol. The red color left the soft mass being extracted by the ether. The solution of the color in ether did not keep the purple tint of the soft mass, but showed a fine brownish coloration, the soft mass itself appearing now as a gray yellowish substance, reminding one of blood fibrine. It could be reduced to ashes and is, therefore, of organic composition. When the lake water was directly exposed to the mixture of ether and alcohol without having passed through acetic acid no result was obtained. Concerning the osmotic property of the red organic mass it is to be noted that it did not pass through a membrane of so-called parchment paper, such as is used for covering jars.

The experiments show that the water of the lakes contains an astonishingly great quantity of organic red substance and that it is this which gives the red color to the water.

The question now arises what the origin of the red organic substance is. My supposition is that the substance must be the product of bacteria. Each drop of water taken from the lakes will be found full of them. The bacteria in all the lakes are uncolored, but I found that the cocci exhibit a red color.

According to 'Baedeker' (Egypt, French edition, 1898) there existed another spot in Egypt, near Suez, where red salt water is found. On page 162 of the guide book I read the following note: "La coleur rouge des marais salants entre des collines des Bédouins et le canal, provient d'une petite écrevisse (de l'ordre des phyllopodes) presque microscopique qui y fourmille à certains moments. Le matin ils exhalent un parfum semblable à celui des violettes." Unfortunately, when I was at Suez I did not visit the 'marais salants,' and I, therefore, wish to call this note to the attention of the biologists visiting that part of Egypt. It would be very interesting to ascertain whether the water there contains bacteria and the same red organic mass which I found in the lakes of the Natroun Valley.

J. DEWITZ.

SCIENTIFIC BOOKS.

Man: Past and Present. By A. H. KEANE. Cambridge Geographical Series. Cambridge, University Press. 1899. 12mo. Pp. 184. Plates 12.

This volume is the sequel to Mr. Keane's 'Ethnology,' which appeared as the first of the series in 1896, and the two must be read together. The author has devoted his life to ethnology, and he has lived for many years in London, surrounded by the best resources of libraries, museums and men. Every authority worth consulting has been within his reach. Mr. Keane is a zealous systematic workman and loves his calling. Let us, therefore, hear what he has to say about man, past and present. The author is an evolutionist who thinks that the genealogy of man is made out. For him the ascent of the Hominidæ is in an independent line from some long-extinct, generalized form, from which the other families of anthropoidia sprung in independent lines. This precursor first appeared in the Indo-Malayan area. Indeed, Dubois's *Pithecanthropus erectus* is assumed as typifying nearly enough the first man.

The time when the precursor became man was in the Pliocene Tertiary, and a million years, more or less, would suffice for all human history. Four sub-species, or varieties of the percursor, were developed in as many separate areas, namely, *Homo Ethiopicus*, *Homo Mongolicus*, *Homo Americanus* and *Homo Caucasicus*.

The centrifugal Pleistocene precursor, erect in posture, but not differing greatly from his nearest ape-like kin in other respects, physical or mental, spread himself over the whole habitable globe. In four separate zones, the four varieties above named were evolved as independently as was the Pleistocene precursor himself. This view has led some to rank the author with the polygenists, but he denies this

and vigorously espouses monogenism. The first chapters are devoted to this generalized man and to the beginning of the historic period. But the bulk of the work treats of the four varieties in detail, and traces with much particularity how each became specialized in its own environment, giving three chapters to *Ethiopicus*, four to *Mongolicus*, two to *Americanus* and three to *Caucasicus*.

I. *Homo Ethiopicus*, developed in two areas, Papuasia and Africa south of the equator. The two sets of peoples, however, are fundamentally one, and the likeness extends to the details of sub-varieties. *Ethiopicus* was the first to branch off from the Pleistocene precursor and develop three sub-varieties. No difficulty is encountered in these early migrations across an Indo-African continent now submerged.

II. *Homo Mongolicus* developed on Central Asian plains and plateaux into three sub-varieties, Mongolo-Tartar, Tibeto-Indo-Chinese and Oceanic Mongols.

III. *Homo Americanus* developed in the New World in Pleistocene times from Indo-Malaysia, whence he came in the primitive state, prior to all cultural developments, by two separate routes, giving rise to two zoological varieties, the Eskimo-Botocudo long-head, who migrated by way of now submerged lands across the North Atlantic; and the Mexican-Andean round-heads, who found their way in the new stone age from eastern Asia by the Bering waters.

IV. *Homo Caucasicus*, whose original home as variety of the Pleistocene precursor was Africa, north of the Soudan, where the Caucasic type was constituted in all its features. He arrived by way of trails across the now submerged Indo-African continent. Thence he occupied the Nile Valley, western Asia, western and central Europe, and worked backward to become Toda in India, Ainu in northeastern Asia, Indonesian in Farther India and Polynesian in the archipelagoes of the Pacific.

Each one of these primitive zoological groups is traced downward, mainly on biological lines to the present ethnic groups. The author has spared no pains in preserving his references in foot notes, thus setting the work away above such general treatises as that of Ratzel. He finds in *Homo Caucasius* the most debatable field, because, he thinks, of the more complex character of the subject. Is it not just possible, however, that our profounder knowledge of this variety makes it more difficult to play the game of synthesis with its parts?

There are three points at which the work could be improved. The publisher has maltreated the author's well selected photographs shamefully. In these days of cheap and excellent graphic processes there is no excuse for this. Some faces are worse than others, but the Toda and the Yezo Ainu, in Plate XII, must have been nearest the cannon cracker when it exploded.

A second weakness also must not be ascribed to the author, for it lies at the door of those who gave him information. For instance, if the members of the National Academy of Sciences agree that Bowers's 'crust,' which was 'busted, falling down a shaft in Calaveras county,' is the cranium of a Pleiocene precursor, Mr. Keane is not to blame for repeating it. Or, if the writer who calls attention to a pair of snow goggles found in a gravel bank at Point Barrow, twenty-six feet beneath the surface, should omit to say that they had been made of driftwood, with a steel knife, and that the same pattern was worn there last winter, who blames Mr. Keane for finding the palæolithic man from the Arctic to Fuegia? Though, we must say that this is the first information of his using snow blinkers.

But, thirdly, the author has marred his book by prejudicial selection of authors. It will certainly grieve some of Mr. Keane's admirers on this side of the Atlantic to find writers quoted seriously who have no standing, while he omits all reference to such distinguished authorities as Daniel G. Brinton, Wm. H. Holmes, Garrick Mallery, Washington Matthews, Charles Rau, Everard M. Thurn and Jeffries Wyman.

O. T. Mason.

The Story of the Mind. By James Mark Baldwin. New York, D. Appleton & Co. Pp. x + 236.

Skill is needed to present psychology in popular form. There is imminent danger of either unreadable technicality or of superficial

chat. Professor Baldwin has escaped both of these and has produced a remarkably good book, which will certainly hold the interest of the lay reader and not forfeit the respect of specialists. The serious-minded who glance superciliously into a book with such a title will probably read far before they lay it down.

The more important departments of the subject are given separate chapters—the mental life of children and of animals, physiological and pathological psychology, social influences, the character of laboratory experiments, and other topics, with a brief introductory view of the general nature of mind and of psychology. The author has not attempted to give the detailed results in these fields, but has chosen some sample problems under the various headings, and stated the case according to our present knowledge. In selecting these he has clearly been guided by his personal interest, taking preferably those topics to which he himself has been an important contributor; and undoubtedly the impression of movement and vitality which the book makes is largely due to the fact that the author is, in a double sense, telling of his own offspring, and can hardly conceal, under his cold and studied phrases, the glow of parental pride. For this reason the various chapters which treat of mental development and the ramifications of the imitative and social instinct are the best parts of the 'story,' and have a swing and security which is scarcely felt in some other portions of the book.

For instance, in the account of the general character of our mental processes, the manner in which the distinction between sensations and their 'apperceptive' connection is treated—the sensations supposedly coming first and from without, while the activity of arranging them springs up later and from within—will help to postpone the good day when all shall acknowledge that sensations are as much an 'inner' affair as is their arrangement or interconnection, and that the 'formal' and 'material' sides of consciousness are but abstractions, both of which are really present in even the simplest mental fact. Consequently they cannot come from different sources nor arrive on the scene at different times. If for popular and pedagogical purposes it seems best to present it otherwise, at least some hint might be dropped so that the wayfaring man who is wise and discriminating need not go astray.

And in the physiological material of the book the reader who is keen for such things might note an objection here and there in the margin. If right-handedness is, as the author admits, but a phase of the wider fact of left-brainedness it seems as infelicitous for him to refer to a 'center for right-handedness' as it would be to speak of a center for right-sideness; it is, as the author says, a matter of the relation of the two sides, and the 'center' consequently would have to include both halves. And if the 'center for right-handedness' becomes later the 'center for speech' the wicked might ask how it is that we do not cease to be right-handed when once we have learned to talk.

In another passage the author refers to very definite anatomical evidence that children have no 'will in any sense' until well along in the first year, for 'the fibers of the brain necessary to voluntary action,' he goes on to say, 'are not yet formed.' In the present state of our knowledge as to just what fibers are necessary for voluntary action this sounds somewhat over-sure; but even though the anatomical connections necessary for the voluntary control of *muscular movements* be wanting, this by no means makes it certain that 'will in any sense' is lacking, seeing that even the laziest interest or listless preference contains the essential of volition, and that the anatomical conditions for such a mental state are not necessarily the same as those for conscious muscular control.

In the chapter on the training of the mind the familiar classification of persons into those of visual, auditory, muscular and other 'types' is given a wider interpretation than the facts will probably allow. Mr. Baldwin seems to assume that a person who is put into the 'motor' class because his mental imagery is predominantly in terms of muscular sensations must also be 'motor' in the sense of preferring to act rather than to reflect, or of being impulsive rather than deliberate. On the contrary, the ordinary imagery-type to which a man belongs does not seem to give us any certain warrant for saying whether he is generally reflective or not, but

only determines which sort of sensation furnishes the common coin of his mental exchange. A person who is motor in this sense may or may not be more impulsive than a good visualizer; it all depends on whether his motor cues habitually bring with them contrary suggestions. Experience seems to show that some of the most hesitating of us act from motor cues, while some of the most impulsive persons are of the 'sensory' and, indeed, of the visual type. We are hardly in a position, therefore, to hold out the hope that the ordinary type-tests will decide whether a boy needs encouragement in precipitateness or in hesitancy. Whether he is too cautious or too headlong is to be settled by observations *ad hoc*, and is not decided by discovering which sense furnishes the stuff of his mental imagery.

But details of this sort to which objections might be raised are not many nor are they so important as to affect the general tone of the book. As a whole it does admirable justice to the more fruitful lines of modern work and will be acceptable to the wide circle of persons who wish some intelligent guidance in psychology, without aiming to be students of it in the stricter sense. Even classes in psychology might well supplement their reading by a fresh narrative like this. And as for the poor school-teachers, accustomed to their juiceless 'teachers' psychologies,' they will with difficulty believe that a book which is really interesting can be the genuine thing.

G. M. STRATTON.

UNIVERSITY OF CALIFORNIA.

How to Know the Ferns. By FRANCES THEODORA PARSONS. New York, Charles Scribner's Sons. 1899. 12mo. Pp. 215. Price, $1.50.

When science has its cold matter of-fact angularities concealed by a certain amount of folk-lore, personal adventure and innocent poetical quotation the popular mind takes it in unwittingly without feeling the chilliness of the morsel, and if they are abraded by the angles, there is lubrication and mollification in the dressing that makes one forget the pain. The ordinary unscientific reader is shocked if told at once that an innocent looking fern is a *Cystopteris*, but when he is introduced to it as the 'bulblet bladder-fern' the added syllables cause him no uneasiness and it is quite a different matter. All this softening of the rough angles of a scientific treatise is heightened if attractive illustration furnishes the ready opportunity to save the often tedious work of identification through technical language.

Such a happy combination we have presented in a most attractive form in the book before us. The popular interest is attracted by the personal narratives and one forgets the personal pronouns; one forgets even the rather doubtful compliment paid to the main subject when one reads that 'the greatest charm the ferns possess is that of their surroundings,' a fact emphasized by the frontispiece where the pose of the handsome young woman surely throws 'the cheerful community of polypody' quite into the shade, yet a more attractive picture could scarcely have been chosen.

The work is well written and is really one that can scarcely do otherwise than interest many people who have neither the time nor the mental perseverance for severe study, in one of the most delightful of subjects, and it will certainly bring many into a closer touch with Nature and her productions. The text is in the main very accurate, and the illustrations really illustrate the subject, and do it so well that one must be blind who cannot with their aid identify the ferns of the Northern States. The drawings by Miss Satterlee with less of the impressionist touch appeal more strongly to the cold scientific eye, though all of them are well executed, and the full-page half tones are well chosen and excellent.

While the authoress appears to us under a new name, we recognize in Mrs. Parsons the same writer that a few years ago as Mrs. Dana gave us the equally valuable book, 'How to Know the Wild Flowers.' Armed with these two, many who heretofore have had only guides that were too severe for their summer's outing can be easily and delightfully introduced to the ferns as well as the flowers of the woods and fields.

L. M. UNDERWOOD.

BOOKS RECEIVED.

Principes d' hygiène coloniale. GEORGES TREILLE. Paris, Carré and C. Naud. 1899. Pp. 272.

Laboratory Manual Experiments to illustrate the Elementary Principles of Chemistry. W. W. HILLYER. New York and London, The Macmillan Company. 1899. Pp. 198.

A Short History of the Progress of Scientific Chemistry in Our Own Times. WILLIAM A. TILDEN. Longmans, Green & Co. 1899. Pp. x + 276.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, July, 1899: 'Camphoric Acid,' by W. A. Noyes; 'Contributions to our Knowledge of Aqueous Solutions of Double Salts,' by H. C. Jones and K. Ota. This is a continuation of the investigation of the double sulphates. The evidence, in the case of the double chlorides, seems even stronger in favor of the hypothesis which has been so strongly emphasized by Remsen, that double salts are true compounds, as this work shows that molecules of double salts exist as such in concentrated solution. 'On Undecylamine and Pentadecylamine and the Preparation of the Higher Amines of the Aliphatic Series,' by Elizabeth Jeffreys; 'An Electric Drying Oven,' by T. W. Richards. The general devices that can be used to secure the desired results in a drying oven are shown when the source of heat is due to electrical resistance. 'On Certain Derivations of Symmetrical Trichlorbenzol,' by C. L. Jackson and F. H. Gazzolo; 'Narcotine and Narceine,' by G. B. Frankforter and F. H. Keller; 'The Reaction between Aliphatic Sulphocyanates and Metallic Derivatives of Acetoaceticester and Analogous Substances,' by E. P. Kohler; 'A Method for Carrying out Chemical Reactions under High Pressures,' by B. H. Hite. The author gives full details for the apparatus necessary for such work.

J. ELLIOTT GILPIN.

THE *Mois Scientifique et Industrielle* is the title of a new monthly journal which has begun publication in Paris. Each number contains an original article and a digest of physical and chemical literature. The subjects covered are physics, including electricity and applications; chemistry and the chemical industries, including metallurgy, dyeing, distilling, sugar making, etc.; the mineral industries; mechanics and the mechanical industries, and agriculture.

SOCIETIES AND ACADEMIES.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE following titles of papers submitted for the Columbus meeting have been received by the secretaries of the respective sections. Additions will doubtless be made to the programs at the time of the meetings.

SECTION B—PHYSICS.

On a new spectrophotometer and spectroscope; On achromatic polarization in combinations of crystalline media: D. B. Brace, University of Nebraska, Lincoln, Nebr.

An apparatus for the demonstration of the varying currents in the different conductors of a rotary converter: F. C. Caldwell, Ohio State University, Columbus, O.

On optical calibration of the slit of a spectrophotometer; Absorption spectra of solutions: E. V. Capps, University of Nebraska, Lincoln, Nebr.

An absolute determination of the E. M. F. of the Clark cell: Henry S. Carhart and Karl E. Guthe, University of Michigan, Ann Arbor, Mich.

The time of perception as a measure of the intensity of light; Relation between space and time in vision: J. McK. Cattell, Columbia University, N. Y.

On the fluting in Kundt's tubes with gases at different pressure; On the escape of gases from planets according to the kinetic theory: S. R. Cook, University of Nebraska, Lincoln, Nebr.

Note on hysteresis curves determined by a yoke with broken magnetic circuit; On the demagnetizing effect of currents in iron when electro-magnetically compensated: Z. E. Crook, University of Nebraska, Lincoln, Nebr.

A new graphical method of constructing the entropy-temperature diagram from the indicator card of a gas or oil engine: H. T. Eddy, University of Minnesota, Minneapolis, Minn.

Some types of March weather in the United States: Oliver L. Fassig, Johns Hopkins University, Baltimore, Md.

Magnetic measuring instruments and the laws of magnetism; some new electric apparatus; wave forms in the aluminum condenser

cell and in the magnetically blown arc; Method of locating point of discharge of smokeless powder by colored screens: Reginald A. Fessenden, Western University of Pennsylvania, Allegheny, Pa.

Polarization and polarization capacity: Karl E. Guthe and A. D. Atkins, University of Michigan, Ann Arbor, Mich.

Accidental double refraction in colloids and crystalloids: B. V. Hill, University of Nebraska, Lincoln, Nebr.

A method for the study of phosphorescent sulphides: Fred. E. Kester, Ohio State University, Columbus, O.

Simple science work for common schools: H B. Mathews, Agricultural College of South Dakota, Brookings, S. D.

Pressure and wave-length: John Fred Mohler, Dickinson College, Carlisle, Pa.

On the effect of concentration series in the copper voltameter: B. E. Moore, University of Nebraska, Lincoln, Nebr.

On the coincidence of the two refracted rays in biaxial crystals: L. T. More, University of Nebraska, Lincoln, Nebr.

Thorium radiations: R. B. Owens, McGill University.

On differential dispersion in double refracting media: E. J. Rendtorff, University of Nebraska, Lincoln, Nebr.

A new voltage regulator: Geo. D. Shepardson, Granville, O.

The relation between magnetism and the elasticity of rods—and some S. H. M. curves: James S. Stevens, University of Maine, Orono, Me.

Note on the preparation of photographic reticles: David P. Todd, Observatory House, Amherst, Mass.

The equipment and facilities of the office of the U. S. standard weights and measures for the verification of electrical standards and measuring apparatus; An experimental test of the accuracy of Ohm's law: Frank A. Wolfe, Jr., U. S. Coast and Geodetic Survey, Washington, D. C.

SECTION F—ZOOLOGY.

Æstivation of *Epiphragmorphora traskii* (*Newcomb*) in S. California: M. Burton Williamson, Los Angeles, Cal.

Natural taxonomy of the class *Aves*: R. W. Shufeldt, Takoma Park, D. C.

Notes on the morphology of the chick's brain: Susanna P. Gage, Ithaca, N. Y.

Further notes on the brook lamprey (*Lampetra wilderi*): Simon H. Gage, Cornell University, Ithaca, N. Y.

Respiration in tadpoles of the toad (*Bufo lentiginosus*): Simon H. Gage.

Photographing natural history specimens under water or other liquids with a vertical camera: Simon H. Gage.

Hybrid butterflies of the genus *Basilarchia*: William L. W. Field, Milton, Mass.

On some piratine bugs which may be responsible for so-called 'spider-bite' cases: L. O. Howard, Department of Agriculture, Washington, D. C.

Observations on the development of mammals: Charles S. Minot, Harvard University, Cambridge, Mass.

The correct systematic position of the *Spongidæ* in Zoology: W. R. Head, Chicago, Ill.

Have we more than a single species of *Blissus* in North America? F. M. Webster, Wooster, Ohio.

On the utility of phosphorescence in deep-sea animals: C. C. Nutting, University of Iowa, Iowa City, Ia.

On the criteria for interpreting the psychology of animals: C. C. Nutting.

A discussion of *Aspidiotus cydoniæ* and its allies: C. L. Marlatt, Washington, D. C.

Temperature control of scale insects: C. L. Marlatt.

SECTION I—SOCIAL AND ECONOMIC SCIENCE.

The psychological value of statistics: Carroll D. Wright, Washington, D. C.

[Title to be announced]: Edmund J. James, Chicago University.

Some new aspects of educational thought: Thomas M. Balliet, Springfield, Mass.

The basis of war and peace: M. A. Clancy, Washington, D. C.

Business cooperation: N. O. Nelson, St. Louis, Mo.

Thoughts on education from the standpoint of Porto Rico: John Eaton, Washington, D. C.

Some thermal determinations in the heat-

ing and ventilating of buildings: Gilbert B. Morrison, Kansas City, Mo.

Science and art in social development: John S. Clark, Boston, Mass.

Moral tendencies of existing social conditions: Washington Gladden, Columbus, O.

The manual element in education: C. M. Woodward, St. Louis, Mo.

[Title to be announced.]: W. B. Powell, Washington, D. C.

Natural distribution, as modified by modern agriculture: John Hyde, Washington, D. C.

Calculations of population in June, 1900: Henry Farquhar, Washington, D. C.

Civil Service in the United States: H. T. Newcomb, Washington, D. C.

Federal guaranties for maintaining republican government in the States: Cora A. Benneson, Cambridge, Mass.

DISCUSSION AND CORRESPONDENCE.

ON THE U. S. NAVAL OBSERVATORY.

THE article on the U. S. Naval Observatory by Professor Asaph Hall, Jr., in the number of SCIENCE for July 14th, treats very effectively of some matters which astronomers have long wished to see altered at that institution. Many able line officers—D. D. Porter and others—have served there, as Professor Hall suggests. Any amount of such service, however, can no more make astronomers than the service of half-pay officers could do in Sir George Airy's time, although at either Washington or Greenwich the habit of naval discipline was a help toward the formation of careful habits of observation. Nor do I suppose that the earlier Greenwich assistants, Baldrey and others, were better astronomers at the start than those at Washington, who brought with them a knowledge of astronomy.

In general we should find in the earlier volumes of the Washington observations precisely what we might expect if we knew the history of the establishment derived from the accessible data beginning with Gilliss's first report, which contains, among other things, the description of the instruments procured, some of them antiquated when they were constructed, others still used to some extent, others now replaced by haphazard constructions for which some one more or less acquainted with the matter is responsible.

In general it may be said that the success or failure of the observatory now in use will be more definitely decided in two or three years after it is better known what the later reports shall indicate as to the constructive ability of the mechanicians who have been employed to replace or remodel the work of Troughton and Simms, Pistor and Martins, Alvan G. Clark and the other makers at first selected.

There is no doubt, I imagine, that the present astronomers at the observatory have had nearly *carte blanche* to do what they would, and we shall learn in a few years whether the immense amount of money expended on it has produced proportionate results, or is likely to appear to do so when they come forth to view. The excuses which were for several years offered for the delay in actually beginning the work on the zone—14° to—18° were not altogether satisfactory, as the astronomer whose observations of it are so quickly accomplished had been many years in service, and there is, so far as I am aware, nothing to show the necessity of the delay, except, if I may speak plainly, the entirely haphazard manner in which the U. S. Naval Observatory had been conducted from 1845 to the actual time of beginning observations on the zone.

It is not, in my judgment, necessary to do more to greatly improve the institution than to follow Airy's example in a simple matter of business according to the general custom at great observatories of the present day.

The appointment of a strong and intelligent visiting committee, to include a few prominent officers of the army and navy, together with a number of eminent and intelligent civilians, would add greatly, almost without expense or trouble, to the definiteness of the plans and the steadiness of the execution of the work of the institution, as one can readily see from the late autobiography of Sir George Airy.

TRUMAN HENRY SAFFORD.

WILLIAMS COLLEGE OBSERVATORY, July 19, 1899.

CEREBRAL LIGHT.

DR. E. W. SCRIPTURE, in SCIENCE of June 16th, gives an account of an experiment which

he holds proves that the so-called 'retinal light' is really 'cerebral light.' The experiment which he considers conclusive consisted in looking at a dimly lighted window in a dark room, the window being so dimly lighted that both the retinal figures and the window could be seen. He then moves the eyeballs with the fingers and notices that the retinal figures are stationary, while the image of the window moves. Dr. Scripture apparently confuses movement of the retina and movement on the retina. What he calls movement in the case of the image of the window is evidently movement of the image on the retina as shown by the 'local signs' of the retina. But the retinal figures, being impressed on the retina, move with it and not on it, and therefore the local signs of the retina give no evidence of its movement.

In repeating the experiment I gazed fixedly at the window for some time. In closing my eyes I had impressed on the retina, in addition to the retinal figures, a faint after-image of the window. If the eyes were now moved, as Dr. Scripture directs, no movement was noticeable in the after-image. It did not separate into two moving images, for this would necessitate a change in position of the two images in relation to corresponding points of the two retinas. If two dissimilar after-images are impressed, one on each retina, and the eyeballs pressed, they, for the same reason, will show no relative motion. Why, then, should we not expect the retinal figures to remain single and immovable, as Dr. Scripture found them to be?

E. B. Wheeler.

Missouri State University, July 24, 1899.

NOTES ON INORGANIC CHEMISTRY.

Two reports have recently been presented to the Home Office in Great Britain which are of considerable general interest, one on the use of yellow phosphorus in matches, and the other on the use of lead in pottery glazes. The first of these reports is by a commission consisting of Professors T. E. Thorpe, S. Oliver and Dr. Cunningham, and the other by Professors Thorpe and Oliver, and both have been reviewed at some length in *Nature*. Only two kinds of matches seem to be considered, the 'strike anywhere,' which is tipped with yellow phosphorus, and the 'safety,' in which red phosphorus is used, and is not on the match, but on the striking surface of the container. According to the report no danger seems to attend the manufacture where red phosphorus is used. In the case of yellow phosphorus, the dangerous processes are mixing the paste, dipping the matches, drying and boxing, this last involving the most handling. Already existing rules in Great Britain require efficient ventilation, non-employment of laborers who have suffered with necrosis or have lost a tooth, immediate medical examination of persons suffering with toothache, notification of cases of necrosis, and proper washing conveniences. The immediate question before the commission was as to whether they should recommend the prohibition of yellow phosphorus. In view of the competition of other countries, notably Belgium, Sweden and Japan, for export trade, and, as it has been shown that proper precautions can prevent danger in manufacture, it was felt wise not to prohibit the use of yellow phosphorus, unless an international agreement could be reached. They suggest, however, more precautions, and point to the Diamond Company, of Liverpool, where no cases of phosphorus necrosis have ever occurred. Unless we are mistaken, not a few of the American manufacturers have solved successfully the problem of tipping the match itself with a paste of amorphous phosphorus, while the use of the 'safety matches' is, happily, rapidly increasing.

The report on lead glazes is more far-reaching in its recommendations, but, according to W. Burton, in *Nature*, is hardly practical. The recommendations are as follows: (1) Prohibition of lead glazes in seven-tenths of the wares produced in the potteries; (2) That in the other three-tenths lead should be used only in the form of a lead silicate frit; (3) The use of lead white in glazes or colors absolutely prohibited; (4) Prohibition of women and children in all processes where they would come in contact with the lead work. Mr. Burton would agree to the second and third recommendations, but considers the first and last impracticable, on account of the difficulty of replacing lead glazes by leadless glazes for many wares, and on ac-

count of foreign competition. He points out the vast difference between laboratory experiments and practical pottery, especially with reference to leadless glazes. He believes that the adoption of the second and third recommendations, together with monthly medical inspection of *all* workers, would put an end to the evils of plumbism.

The *Zeitschrift für angewandte Chemie* gives an account of a recent explosion in a Swiss school in connection with experimentation on oxygen. The oxygen was contained in a glass gasometer, which had been previously completely filled with water, and had been generated from potassium chlorate. Unknown to the teacher, the gasometer had earlier been used for acetylene and the water had not been renewed. It seems probable that sufficient acetylene had been dissolved by the water to give an explosive mixture with the oxygen.

In the *Philosophical Magazine* for June, Gerald Stoney gives an interesting comparison of the amount of oxygen in the atmosphere and in the exterior of the earth. Above a square centimeter of the earth's surface are 234.5 grams oxygen. The same amount would be contained in a column of water of the same section and 264 centimeters deep, and in a still shallower column of the earth. Considering the earth's 'crust' to be of approximately constant composition to a depth of seventeen miles, the amount of oxygen in it would be more than ten thousand times as great as that in the atmosphere.

At the recent Royal Society's Conversazione, Sir Wm. Crookes exhibited photographs of lines high in the ultra violet region, characteristic of a new element associated with yttrium and separated from it by long fractionation. The element has an atomic weight, probably near 117, and its oxid in the purest state yet prepared is of a pale brown color. The name of *victorium* has been given to the element.

Note was recently made of the investigations of Parmentier, tending to show that fluorin is not present in certain mineral waters, as had been previously held. In a succeeding number of the *Comptes Rendus* Charles Lepierre maintains that minute traces of fluorin have been detected in many mineral waters, and no less than ten or twelve milligrams per litre are present in the Gerez water (north Portugal). This water is considered very efficacious in liver diseases.

A paper was recently read before the Royal Society by David Gill on the presence of oxygen in the atmosphere of certain fixed stars. A study of the spectrum of β *Crucis* reveals the presence of all the stronger oxygen lines as well as all the known helium lines. On the other hand, no trace of true nitrogen lines are found in the spectrum. Hydrogen is present, and probably carbon and magnesium. The spectra of β and ϵ *Canis Majoris* and probably β *Centauri* are practically identical with that of *Crucis*. J. L. H.

CANNIBALISM IN QUEENSLAND.

Eugene F. Rudder contributes to a recent number of *Science of Man* (Vol. 2, No. 3, Sydney, April 21, 1899) interesting personal observations on the Blackfellows of Queensland. Accidentally he stumbled on a silent but apparently ceremonial feast on the flesh of 'a very powerful, well-conditioned black,' who had been shot in an attempt to escape from capture for some offense the day before. The skin had been removed entire and was drying before the fire on five spears set in the ground; and, on detection, the group of blacks deserted their work and did not reappear. Inquiry among other blacks yielded little connected information concerning the case, except that 'It make 'im blackfellow strong fellow'; but more general inquiries elicited the information that the anthropophagy was commonly limited to the bodies of those killed in battle or by accident, and that the feast was ceremonial and usually limited to the kinfolk of the deceased. In one case a girl was speared and eaten by two rivals for her hand; the body was cooked on a sort of platform of green poles, laid above the glowing coals of a large fire when nearly burned down. Another case was the killing and eating of a female child by the mother; this is said to be an established custom in case of excess of female children, or in case of deformity, the custom being enforced by capital punishment, and the

belief underlying the custom being the characteristic notion that the powers of the consumed are thereby conveyed to the consumer. A related belief finds expression among the same people in the practice of opening the abdomen of an enemy killed in battle, extracting the caul fat and annointing with it the body of the victor, the ceremony taking place while the body of the victim is still warm, or, if practicable, before his death. In all cases, of anthropophagy the skins were carefully removed, dried, and then hung in high trees to be blown about by the winds.

W J M.

PROPOSED INSCRIPTION FOR THE STATUE OF DARWIN.

We recently quoted from the London *Academy* inscriptions proposed for the statue of Darwin. Mr. Edward Montgomery, of Hemstead, Texas, suggests the following substitute:

> Charles Darwin, whose painstaking biological investigation has demonstrated the developmental ascent of lowest to highest forms of life, proving Evolution to be the master-key to the secrets of nature, and opening to striving humanity the inspiring prospect of natural perfectibility.

We have also received from 'Milner Kenne' the following sonnet:

CHARLES DARWIN.

Father of Science, versed in Nature's lore,
  Toilsome unraveller of her mystic laws,
  Tracing by painful thought effect to cause
Till, like Columbus, thou new worlds explore;
Say, shall we ever see thy equal more?
  Modest as great, yet fearless without pause,
  Careless alike of censure or applause,
Steering still onward to the unknown shore.

To thy keen sight, thy patient thought and clear,
  The newer science owes nativity.
Thy sunlike mind bids ignorance disappear
  Till Nature's wonders seem to mirror thee,
And to us mourning say in words of cheer,
  Si monumentum quaeris, aspice!

THE NATIONAL ZOOLOGICAL PARK.

The following circular letter has been sent by the Secretary of the Smithsonian Institution to officers of the army serving in the Philippines, Cuba, Porto Rico and Hawaii and on other outside stations:

The Secretary, on behalf of the Regents of the Smithsonian Institution, and with the permission of the Honorable the Secretaries of State, of War and of the Navy, calls the attention of officers of the United States on foreign stations to the fact that there is at the capital a National Zoological Park, established by an Act of Congress approved April 30, 1890, which provides:

> That the National Zoological Park is hereby placed under the direction of the Regents of the Smithsonian Institution, who are authorized to transfer to it any living specimens, whether of animals or plants now or hereafter in their charge; to accept gifts for the Park at their discretion, in the name of the United States; to make exchanges of specimens, and to administer the said Zoological Park for the advancement of science and the instruction and recreation of the people.
>
> That the heads of the executive departments of the government are hereby authorized and directed to cause to be rendered all necessary and practicable aid to the said Regents in the acquisition of collections for the Zoological Park.

This Park, of which some idea may be formed by the accompanying map and illustrations, has been established in an unusually beautiful site near the city of Washington. It is intended to form here a representative national collection which, while especially rich in our native American animals, shall also contain specimens from all parts of the world, and shall be to America what the zoological gardens at London, Paris and Berlin are to their respective countries.

For several years Congress made no appropriation for the purchase of animals, and the Park is still largely dependent upon gifts to increase the collection, which is far from adequate as an exhibit in a national institution.

If officers stationed abroad who may be interested in animal life would bear in mind the necessities of the Park many additions could be made to the collection. Almost any foreign animals would be gladly received.

Expenses of boxing and of land transportations, where necessary, will always be paid by the Zoological Park.

Purchase of animals can be made only in exceptional cases, but if the opportunity for any especially desirable acquisition arises the Secre-

tary of the Smithsonian Institution would be pleased to be advised by letter or, in urgent cases, by telegraph. The Secretary would also be glad to correspond with officers who expect to visit regions where interesting animals occur.

Public recognition of gifts is made, the names of donors being placed upon the labels attached to the cages or pens, and a notice of the gifts, with the names of the donors, is also made a part of the annual report of the Secretary of the Smithsonian Institution.

A list of the most important animals that can be collected in different countries is appended hereto, and concise directions for boxing, shipping and feeding are given.

SCIENTIFIC NOTES AND NEWS.

A CABLEGRAM from Cairo dated July 27th states that Mr. N. R. Harrington, instructor in Western Reserve University, has died at Atabara of typhoid fever. Mr. Harrington was a member of the Senff zoological expedition of Columbia University, which was on its way to the upper Nile for the purpose of studying the embryology of *Polypterus*.

REPORTS from the *Elder*, carrying the party of men of science taken to Alaska by Mr. E. H. Harriman, state that the trip has been in every way successful. The steamship is now returning from Kodiak to Sitka.

MAJOR MARCHAND is to be presented with the grand gold medal of the French Geographical Society for 1900. Silver replicas will be given to all the officers of his mission. Major Marchand has been appointed to the 4th Regiment of Marines and his subordinates have also been reincorporated in the army.

MR. H. N. DICKSON, of New College, Oxford, has been given the Johnson Memorial Prize of the University for his work on 'The Currents in the North Sea.'

DR. E. A. DE SCHWEINITZ, Director of the Bio-chemic Laboratory of the U. S. Department of Agriculture and Dean of the Columbian Medical School, Washington, and Dr. R. de Schweinitz, professor of ophthalmology, of Jefferson Medical College, Philadelphia, attended a meeting of the Paris Academy of Medicine on June 12th.

DR. E. PFLÜGER, professor of physiology at Bonn, well known for his physiological researches and as editor of the *Archiv für die gesammte Physiologie*, commonly known as Pflüger's Archiv, recently celebrated his 70th birthday.

DR. V. VON LANG, professor of physics in the University of Vienna, has been elected General Secretary of the Vienna Academy of Sciences.

THE Linnæan Society of London has elected the following foreign members: M. Adrien Franchet, of Paris; Dr. E. C. Hansen, of Copenhagen; Professor Seiichiro Ikeno, of the University of Tokyo; Dr. Eduard von Martens, of the University of Berlin, and Professor G. O. Sars, of the University of Christiania.

THE Liverpool Section of the Society of Chemical Industry proposes to collect £300 for the establishment of a lectureship to commemorate the services to applied chemistry of the late Dr. Ferdinand Hurter.

THE Right Rev. Charles Graves, F.R.S., Lord Bishop of Limerick, has died at the age of 87 years. He was formerly professor of pure mathematics at Trinity College, Durham, and has made many contributions to mathematics.

THE *American Anthropologist* publishes an obituary notice, by Mr. A. R. Spofford, of Mr. Manning F. Force, who died at Sandusky, Ohio, on May 8th, at the age of 75. He was one of comparatively few Americans who, while engaged in other pursuits—he was a Judge in the Superior Court—took an interest in science and contributed to its advancement. His work on the Mound-Builders of the West is a standard authority on this subject.

THE annual meeting of the corporation of the Marine Biological Laboratory will be held at the laboratory at Woods Holl, Mass., on Tuesday, August 8, 1899, at 12 o'clock, noon, for the election of officers and trustees, to act on an alteration of the by-laws and to transact such other business as may come before it.

AN International Hydrographic and Biological Congress for the discussion of the conditions of the North Sea and North Atlantic Ocean met at Stockholm on June 16th.

THE German Anthropological Society and

the Anthropological Society of Vienna will meet together at Lindau on September 4th.

At the International Congress of Zoology, which is to be held in 1901 at a place in Germany yet to be determined, the prize founded by the Czar of Russia will be awarded for the third time. The subjects proposed are: 'Influence of light in the development of colors in Lepidoptera: the causes determining the differences of color, form and structure of parts covered during the resting position in insects.' The papers may be either printed or in manuscript. There are two conditions, the grounds for which it seems somewhat difficult to understand. The papers must be written in French, and those living in the country in which the Congress is held may not compete.

Messrs. Warner & Swasey, of Cleveland, the well-known telescope makers, have presented to Western Reserve University a telescope and dome and other astronomical apparatus. The telescope is a ten-inch instrument. Of its size it will probably be the best which Warner & Swasey have made. The telescope and dome will be placed on the tower of the Physical Laboratory, and will be erected, probably, early in September. Frank P. Whitman, professor of astronomy and physics, is the successor of the late Professor Elias Loomis, of Yale University, and Professor Charles A. Young, now of Princeton University.

The National Museum, through the Bureau of American Ethnology, has just received from California the entire Hudson collection of Indian basket work. This fine collection is one which never can be duplicated, as basket making is already a dying art among the Indians. The Hudson collection numbers about 325 pieces, of which many would sell at $100 or more each in San Francisco. It was made by Dr. J. W. Hudson during about twenty years' intimate association with the Pomo and other Pacific coast tribes. Many of the specimens are sacrificial baskets, which are made with great labor, and are seldom obtained by collectors, being burned on the death of their owners. Foreign institutions have sought to secure this collection, but failed. Professor McGee, of the Bureau, and Professor Holmes, of the Museum, obtained an option on it last year. The price to the National Museum was almost nominal, by reason of Dr. Hudson's desire to have the collection remain in this country.

The *Electrical World* states that but few of the priceless relics associated with the name of Volta were saved from the buildings of the Volta Centenary Exposition destroyed at Como, on July 8th. Among the articles saved was one of Volta's early piles, about twenty manuscripts, a few of his letters and a few books that had belonged to his library. An irreparable loss was that of his laboratory notes and scientific correspondence. In the accounts of the destruction of relics the first electrophorus and first absolute electrometer are not mentioned among the articles saved. Among other losses were a number of Ferraris's models and some of his manuscripts and diplomas. Among the former was the first model of the rotary field. This is presumably the same that in 1893 was forwarded to the Chicago Exposition by a vessel which was sunk in the harbor of Genoa, but subsequently raised and the model recovered and sent to Chicago, where it was exhibited.

A preliminary report, says *Natural Science*, upon the results of the scientific expedition to the island of Socotra has been issued by Mr. Henry O. Forbes, Director of Museums to the Liverpool corporation, who, under the auspices of the Royal and Royal Geographical Societies of London, and of the British Association, and in conjunction with Mr. W. R. Ogilvie Grant, representing the British Museum, undertook the investigation of the natural history of the island. The expedition occupied a period of about six months, and the investigations were conducted amid considerable difficulties. At one time all the members of the party were laid down by a pernicious form of malaria, and they also suffered from frequent attacks of fever. The party was fortunate in discovering many new species of plants and animals, and a valuable collection has been brought home. According to the report the Socotrians are only poorly civilized Mahommedans, living in caves or rude cyclopean huts, and possessing but few

utensils, implements or ornaments, and no weapons. The ethnographical collection is consequently small. The plant specimens have been handed to a well-known student of the flora of Socotra, Professor I. Bailey Balfour, of Edinburgh University, who describes them as of high scientific interest and of great commercial value. The cultivation of some of them is being undertaken in the Royal Botanic Garden at Edinburgh. The report concludes by congratulating Liverpool on being the first provincial corporation to further the advancement and increase of knowledge by actively sharing in the investigation of unknown regions.

THE *Auk* reports the return of Mr. George K. Cherrie from his expedition to Venezuela, where he spent twenty-one months collecting for the Tring Museum. His field was the Valley of the Orinoco, from Ciudad Bolivar to the Ventuari River, above the falls and beyond San Fernando de Atabapo. He devoted his time almost exclusively to birds, but collected some insects and small mammals. Many nests and sets of eggs were forwarded with the birds. He reports that collecting between Ciudad Bolivar and the first falls of the Orinoco was rather disappointing and monotonous; while individuals were abundant the species were surprisingly few. Above the falls the fauna changed rapidly; the number of species increased, and with every move up the river new forms appeared. Fly-catchers, Wood-hewers and Ant-thrushes were the dominant forms, while there was a striking scarcity of Humming-birds. Mr. Cherrie'e work was cut short by serious illness, which compelled his withdrawal from the country with his work only begun.

IN reply to a recent letter from the Liverpool School of Tropical Diseases in regard to the prospective research expedition to West Africa the Colonial Office write, according to the London *Times*, that "Mr. Chamberlain had learned with great satisfaction that the expedition of the Liverpool School is being sent, and appreciates the energy and public spirit shown by the Committee of the School in the matter. The authorities at Sierra Leone will be instructed to give every facility to the work of the expedition." The Colonial Office have also sent for the use of the School valuable medical and sanitary reports of various tropical colonies, and the India Office have sent their medical publications. The British Museum directors have been invited to send with the expedition their dipterologist, Mr. E. E. Austen, offering to pay his expenses. The expedition is expected to throw an important light on the theory held by Major Ross and others as to the propagation of malaria by mosquitoes. The expedition was to start on July 29th and proceed direct to Sierra Leone, and will set to work at once in a district which then happens to be peculiarly unhealthy. It is intended afterwards to make investigations at Accra. The Belgian government have sent an officially-appointed delegate, Dr. S. Van Neck, to visit the Liverpool School of Tropical Diseases and accompany the expedition.

Natural Science states that the Indian Marine Service steamer, the *Investigator*, has recently closed a season of surveying, with important results both for navigation and zoology. The *Investigator*, starting from the Moulmein River, in Burma, last January, steadily surveyed—and her surgeon-naturalist, Captain Anderson, trawled—across the bay to the northern end of the great Andaman, and fixed the position of the island for the first time. Thence the longitudinal position of Port Blair, the capital of the penal settlement of the government of India, was fixed by running a meridian distance to Double Island, off Burma. When at work in the Middle Straits, between the two largest islands, the ship's staff had the assistance of forty tamed Adamanese pigmies against their as yet savage countrymen, who of late have killed several of the Indian convicts near Port Blair with poisoned arrows. The fifteen islands in the three groups of the Cocos, four Andamans and nine Nicobars, will henceforth be a help instead of a danger to the busy mercantile marine plying between Calcutta, Madras, Burma and the Straits Settlements. The deep sea trawl went down in some cases from 480 to 800 fathoms, from which Dr. Anderson brought up not a few valuable additions to his collections.

THE Seine below Paris is now free from sew-

age. A law of July 10, 1894, allowed five years for this operation, and it has been punctually accomplished with two days to spare. The great collector at Clichy has been closed, and henceforth half a million cubic meters of sewage daily will, instead of being discharged into the Seine, find an outlet at Achéres, Méry and Gennevilliers, to be spread over 3,500 hectares of land.

UNIVERSITY AND EDUCATIONAL NEWS.

The Ahearn bill, passed by the recent New York Legislature, allows $96,000 to be spent on free lectures next year in New York City, being an increase of $36,000 over last year. The lectures are largely on scientific topics and are doing much for the education of the people.

We learn from *Natural Science* that the colonies of the west coast of Africa have adopted a scheme whereby picked boys shall be sent for training in horticulture and economic agriculture, first to Jamaica and afterwards to Kew Gardens. This scheme is due to the success that attended the experiment initiated by the then Governor, Sir A. Maloney, of sending in 1890 two native lads from Lagos to be trained as gardeners at the Jamaica and Kew Gardens. After spending two years and a half in Jamaica they were attached to Kew Gardens for some months, and are now in charge of branch botanic stations in Lagos, growing and preparing agricultural products and giving instruction.

Dr. W. Wace Carlier, in the University of Edinburgh, has been appointed professor of physiology in Mason University College, Birmingham.

Dr. Adelbert von Waldenhofen, professor of applied electricity at the Vienna School of Technology, has retired, after more than fifty years of service.

Professor A. Wilmer Duff, now of Purdue University, Lafayette, Ind., has accepted the professorship of physics in the Polytechnic Institute, Worcester. Professor Duff received his B. A. degree in 1884 in New Brunswick, after which he went to Europe for advanced study in the University of Edinburgh. Here he studied with the distinguished physicist, Professor Tait, and in 1888 received the master's degree, with first-class honors, in mathematics and mathematical physics, receiving also a fellowship in physics. In 1888 and 1892 Professor Duff studied in Berlin, having, in 1889 and 1890 filled temporarily the professorship of physics in Madras, India. Since 1893 he has filled the chair in physics at Purdue University with great success. He is a fellow o the American Association for the Advancement of Science, and has made a number of important investigations in physics which have been published in the *Philosophical Magazine*, the *Physical Review* and other leading scientific journals. At present he is engaged on some researches on sound, of great scientific and practical importance.

Professor A. W. French, formerly of the Thayer School of Civil Engineering, Dartmouth College, has been appointed professor of civil engineering in the Worcester Polytechnic Institute. Professor French was educated at Dartmouth College and at the Thayer School of Civil Engineering, from which he received the degree of C.E. in 1892. The Thayer School is well known to be of the first rank in the United States as a graduate school of civil engineering. Its courses are probably more exacting and extensive than those of any other institution. After his graduation Professor French spent two or three years in practice, serving as assistant engineer to Tower Brothers, of Holyoke, and as engineer in charge of the Platte River Paper Mills. Subsequently he was engineer in charge of the Denver and Platte Pumping Station, and this was followed by an appointment as assistant engineer on the Denver and Gulf Railway, especially in bridge designing. In July, 1895, he was called to an associate professorship in the Thayer School, from which he was graduated. He filled this chair most acceptably to the Director, Dr. Robert Fletcher, until 1897, when he resigned for the purpose of again taking up the practice of his profession with the object of obtaining a more varied experience in actual field and construction work. During the past two years he has been the principal engineer of the Niagara Engineering Works, Niagara Falls, New York, which position he leaves to come to Worcester.

SCIENCE

FRIDAY, AUGUST 11, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

As SCIENCE has already announced, the 48th Annual Meeting of the American Association for the Advancement of Science will be held from the 21st to the 26th of the present month, under the presidency of Professor Edward Orton, at Columbus, Ohio, in the buildings of the Ohio State University. By certain members of the Council at the Boston meeting last year it was thought that the acceptance of the invitation from Columbus, involving the rejection or postponement of the acceptance of an urgent invitation from Philadelphia, was hardly wise in view of the fact that they hoped that with the Boston Anniversary Meeting a period of renewed prosperity would begin with a series of large and enthusiastic meetings. Nevertheless, the vote in favor of Columbus showed that a large majority of the members of the Council were impressed by the arguments presented by Professor B. F. Thomas, who laid the claims of Columbus before the meeting, and by those of ex-President Mendenhall, who also spoke in favor of Columbus. The fact that a meeting has never been held before in that city was brought out, and the function of the

Association embodied in its name and which concerns itself with the *advance* of science in different parts of the country seemed to be the deciding argument. From present prospects those who feared that to meet at Columbus would mean a small and unenthusiastic attendance are likely to be agreeably surprised. The preliminary programs of Sections A, B, F, G and I, all that have been published in advance, show sufficiently long lists of important papers ; the announcements from the Local Committee show great interest and good organization, and we are informed by the Permanent Secretary that the nominations of new members are rapidly coming in and that the advance payments of dues are much more numerous than in previous years. An organized effort has been made by the Local Committee, comprising all the teachers in scientific branches in the State University and other prominent persons in Ohio, to interest and attract especially the scientific workers of the Central States. This is a region filled with universities, colleges and other institutions of learning, yet in the past it has not been properly represented in the Association. In point of membership Massachusetts takes the lead, followed by New York, District of Columbia and Pennsylvania, Ohio ranking as fifth with only 99 members as against nearly 400 resident in the State of Massachusetts. That a national association of the broad scope and aims of the A. A. A. S., should draw one-fifth of its membership from the State of Massachusetts seems paradoxical at this time, although 25 years ago it was quite to be expected. It is greatly hoped that the present movement to interest the Central States to a much more marked degree will be successful and will have a permanent effect.

In a similar editorial published a year ago we sketched briefly the career of the Association, showing that beyond doubt it has been of incalculable value to American science, and considering briefly some of the causes of the change in its relation to the science of the United States during the past 15 or 20 years. The greatest of these causes has been, without doubt, the organization of so many special societies which have diminished the interest in the old Association. Times and conditions have a habit (and it is generally a good habit) of changing. The American Association of 30 years ago did its work and did it well, but it must accommodate itself more and more to changing conditions. It has attempted to do this, as we showed last year, by an increase in the number of its Sections, and very lately by its effort to attract to it as affiliated societies the larger and stronger of the new organizations of special character. Does not the experience of the past few years bring us to the logical conclusion that the Association is bound in future to become more and more a central organization around which will rally annually the best of the special societies? That absolute harmony may exist under these conditions is shown conclusively by the experience of the American Chemical Society and the Geological Society of America, both of which have the custom (prescribed in the by-laws of one of the societies and becoming a permanent fixture with the other) of holding a summer meeting with the Association. Nothing could be more harmoni-

ous or more mutually helpful than the joint meetings which have been held for the past three years of Section C of the Association and the American Chemical Society. Far from being a loser by the founding of this society, the Association has profited by it in no small degree. Is not this an indication of what may be done and, in fact, of what will be done with other sections and other societies not limited geographically?

Reference has been made to the fact that membership in the National Academy of Sciences has destroyed to a great degree the interest which certain of the most prominent men of science in the country once felt in the American Association. That this was and is still true cannot be doubted, but we trust we are not mistaken in saying that we think that we can see signs of a change. Especially since the meeting of the British Association for the Advancement of Science at Toronto, so much has been said in American scientific circles of the importance of the attendance of prominent men of science at the meetings of the British Association as a factor in its great success that prominent Americans cannot fail to have appreciated the point, and surely the large attendance of prominent men at last year's meeting is an indication of a revival of interest on the part of this class, even when we consider that the Boston meeting was an anniversary of great importance.

Apropos of the British Association we are reminded of the editorial published in the *American Naturalist* for January, 1899, under the title 'The American *vs.* the British Association for the Advancement of Science: A Comparison.' In this editorial were compared the membership, the invested funds, the average attendance, the expenses and the sums devoted to research grants of the two Associations, naturally much to the advantage of the British Association. The main explanation pointed out was the geographical one—the wide extent of our own country as compared with that of Great Britain. The remedies suggested were either to break up the American Association into Atlantic, Mississippi and Pacific branches or else to make the meeting so interesting and valuable that members will attend them in spite of individual expense. Rightly enough, the last remedy was the one chosen as preferable, and the first step to bring this about was considered to be the determination of the best scientific men of the country to attend the meetings at a sacrifice of time and money. With this also we agree as well as with, in the main, the other suggestions of the editor of the *Naturalist.* We are of the opinion, however, that in his comparison of the two Associations the writer of the editorial too greatly favored the British Association.

In point of relative attendance at the meetings it must be noted that the proportion of members who attend the meetings of the American Association is quite as great as a rule as is the case with the British Association. The very large numbers recorded at the meetings of the latter Association are due in the main to the large numbers of associates and ladies who pay fees and in this way become the principal financial support of the Association. Thus in the year of largest attendance of the British Association, at the Manchester meeting in 1887, when 3,838 persons regis-

tered and paid fees, 1,985 were associates, 493 were ladies and 92 were foreigners, making a total of 2,570, and leaving but 1,268 actual members of all sections. Assuming the total membership to have been 5,000 the attendance at the largest meeting was only about 25 per cent. of the membership, which brings it to about the average attendance at the meetings of the American Association.

This, however, does not bear seriously upon the main question, except as showing that the American Association by comparison is not in such bad condition as might be supposed. Moreover, it might be indicated that there is a very large fluctuation in the attendance at the meetings of the British Association, as, for example, take the four years prior to 1898: At Oxford, in 1894, 2,321; at Ipswich, in 1895, 1,324; at Liverpool, in 1896, 3,181; at Toronto, in 1897, 1,362. Glancing over the table of attendance, in fact, it seems plain that there is a fairly constant attendance of actual members; that the fluctuations are due to the associate class, and that the large numbers and the large sums of money are gained by meeting in large centers of population. The financial support of the British Association, therefore, depends not only upon its prestige, but upon the work of the Local Committees in charge of the individual meetings and upon the custom of inviting contributions by way of associate memberships.

As to the minor and detailed suggestions in the *Naturalist's* editorial, the reports of the Permanent Secretary submitted to the Council meetings of the American Association in December, 1898, and April, 1899, indicated that all the points mentioned are receiving proper consideration and that reforms have been inaugurated which will result in a very considerable saving of the annual expenses of the Association. For example, a new printing contract has been made whereby the cost of printing will be reduced about one-third, and the items of office hire and janitor's salary have been done away with.

Two points connected with the meetings which have been frequently criticised, and which have been instrumental in preventing the attendance of a considerable number of men who ought to attend, are (1) the interruption of the scientific work of the Sections by excursions and social features, and (2) the time of the year when the Association meets. A well known member of the Association says in a recent letter: "For those who are really in earnest about the work of the Association I believe another great defect is the prominence given to junketing. To busy men, and men especially anxious to present the results of a long investigation, it seems trivial to break up a session of the Association to go off on a clam bake or something." This criticism is a well founded one and is appreciated by the Council, and, in fact, at the spring meeting a resolution was adopted requesting the Local Committee at the Columbus meeting to arrange that no excursions or social features should be planned to begin before 4 o'clock in the afternoon, the all-day excursion being relegated to Saturday at the end of the meeting, thus leaving five solid working days for the sessions of the sections. The other criticism, concerning the time of year when the meeting is held,

is one which has frequently been discussed both in the Council and before the Association. It is true, the weather is apt to be warm the third week in August, and it is true that many Eastern college men dislike or are unable to interrupt their vacations abroad or at the seashore or mountains when their fall terms do not open until late in September or the 1st of October. It is true, also, that many members, both college men and those connected with the government surveys and investigating bureaus, are unable to interrupt their long field trips to out-of-the-way portions of the country. On the other hand, however, many of the Western colleges and most of the normal and high schools, from which institutions the Association derives many members, constituting a class in which it ought of right be especially strong, begin the fall term about the 1st of September, and to fix the meeting time at a later date would prevent their attendance. There are also obvious objections to a winter meeting on the part of perhaps a majority of the members of the Association. That college men from a comparatively limited section of the country can hold successful meetings during the winter holidays has been abundantly shown by the experience of the American Society of Naturalists, the Society of Morphologists, and the kindred organizations which meet together each year at that time. The experiment of midwinter meetings of an individual Section of the American Association in connection with the organizations just mentioned has been tried successfully, and there is no strong reason why it should not become a custom. Another alternative which has been suggested is to hold the meeting in late June or early July. The National Educational Association meets at about that time, but draws largely from a rather different class of workers. It might, however, be worth while for the American Association to try the experiment of such a change of date.

Looking over the ground as a whole, it seems to us that the American Association even in its present condition is a good and sound working body of scientific men. Its aims are admirable, and its policy is adjusting itself to rapidly changing conditions. No one denies that it can be improved, but this improvement must naturally be of rather slow growth, and depends on the active interest of the scientific men of the country in its objects, their appreciation of all it could do, and their determination to help in its work.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

REPORT FROM COLUMBIA UNIVERSITY.

PRESIDENT SETH LOW, LL.D., COLUMBIA UNIVERSITY—*Dear Sir:* The committee appointed by you beg to report on the plans for an International Catalogue of Scientific Literature as follows:

We regard the establishment of such a catalogue as one of the most important contributions that can be made to the advancement of science, and greatly appreciate the efforts of the Royal Society to carry it into effect. We think that all institutions and all men of science should do everything in their power to perfect the arrangements for the catalogue and to promote its efficiency.

We submit herewith discussions of the several schedules of classification from professors of this University engaged in teaching and carrying out investigations in the different sciences. We do not as a commit-

tee endorse all the recommendations made, but call attention to the following points, partly contained in these criticisms of the separate schedules and partly concerned with the catalogue as a whole.

The Royal Society appears to us to have made a serious mistake in failing to consider bibliographies already in existence. Its first duty should have been an examination and comparison of these bibliographies. Those men of science who have given years of thought and labor to the subject should have been invited to consider the merging of the bibliographies under their control into the larger scheme and should have been made chiefly responsible for the classifications of the sciences and for the other plans. We are not even told who are responsible for the schemes of classification. These are of unequal value, closely related sciences being in some cases treated very differently. The Royal Society has now asked the advice of various institutions, but the time until the first of January next seems to us altogether too short to make the necessary arrangements. We recommend that the beginning of the twentieth century be chosen for the commencement of the catalogue.

The centralization, elaborate machinery and governmental support proposed by the Royal Society do not always lead to greater efficiency than individual initiative. The possibility of improving and coordinating existing bibliographies instead of crushing them has apparently not been considered. We recommend that the Royal Society draw up and publish at as early a date as possible full details of existing bibliographies of the sciences.

We regard the card catalogue as more important than the book catalogue, and more in need of a central bureau for distribution. The Royal Society's Committee have, however, not considered the card catalogues already in existence or the possibility of securing entries for card catalogues from the compilers of existing bibliographies. They recommend a card 5 x 3 in., forgetting that even in Great Britain the metric system is used for scientific work, and apparently not knowing that standard cards in the metric system are in use throughout the world. We have in this University hundreds of thousands of such cards in use. It would be desirable to supply cards in both of the standard sizes—5 x 12.5 cm. and 7.5 x 12.5 cm. In the specimen cards given by the Committee of the Royal Society no effort is made to print the entries at the top of the card, which seems to indicate that the Committee are not familiar with the method of filing the cards. The cards should be punctured for a bar to keep them in place. Uniform methods of citation are not followed in the different sciences. The method used in botany appears to us the best for all the sciences, except that the year of publication should probably be transferred to the end. We recommend that the Royal Society report on methods of citation employed in existing bibliographies and make recommendations for the adoption of a uniform system.

In regard to classifications, it is evident that bibliographical convenience rather than the logic of the sciences is the matter to be considered. From either point of view there appears to be as much reason to make mechanics, anatomy and pathology separate sciences as meteorology and crystallography. The exclusion of applied science may be necessary, but it is unfortunate, and will probably lead to the continuation or establishment of bibliographies in chemistry, electricity, geology, pathology, etc., more useful to students than a catalogue confined to pure science. The sub-classifications in new decimal systems for each science may be desirable, but it is not certain that a minute classification by symbols is better than an alphabetical classifi-

cation, or that the new systems proposed are better than the Dewey system, already used in the bibliographies of several sciences. In physiology, for example, there are some 800 classes into which it is expected that 3,500 entries per annum will be sorted. Cards would need to be duplicated many times to be placed in all the sub-divisions to which an article may refer. The schedules of classifications are open to many criticisms. We recommend that the classification of each science be referred to committees who shall especially consider the classifications in existing bibliographies.

J. McKeen Cattell,
H. F. Osborn,
R. S. Woodward.

REPORTS ON THE SEPARATE SCHEDULES.

A. MATHEMATICS.

1. 'A' designates in one place Mathematics, in another 'Pure Mathematics.' No provision is made for Mechanics.

2. Under Bibliography a list and description of the various mathematical journals, especially of the bibliographical journals might well be included.

3. Under Arithmetic a sub-division might well be devoted to continuity, countability, etc. (Jordan, Canton, Stoltz).

4. Under Algebra and Theory of Equation, 1250, Klein's theory of the reduction of the solution of equation to the theory of linear groups seems to have been overlooked. In fact, this number (1250) represents far too much, and ought to be divided.

5. Under Groups a sub-division might be given to congruence groups. No. 2010 includes too much.

6. Under Calculus belong mean value and probability. The latter is unprovided for anywhere.

7. 5210, the title is ambiguous.

8. Under Analytical Plane Geometry there should be a sub-division on coordinate system, projection, metrical geometry, etc.

F. N. Cole.

B. ASTRONOMY.

(No schedule submitted.)

B. PHYSICS.

The very greatest care should be used in the details of the classification.

Everything of interest should appear once, and only once, and then in its natural association.

Upon this point rests the working value of the lists. A class should be sub-divided in proportion to its natural sub-divisions and not to the amount of literature covered.

Primary Divisions.

Bibliography should have a section unconfused by others.

Dynamics should not be separated from the theories of matter and ether. Confusion is sure to arise when 'heat' is separated from 'thermal effects' and from 'invisible radiations.'

I. Bibliography.

II. Dynamics of solids, liquids and gases, including vibrations and wave motion.

III. Heat. Including temperature, specific and latent heat.

IV. Radiant energy. Including radiant heat, light and ultraviolet.

V. Electrochemistry and electrolysis.

VI. Electricity and magnetism. The title electromagnetism is misleading; it applies now to a small section of the subject.

It may be argued that any classification will be artificial and each person must learn the classification of his section. But the value of the lists in libraries will lie almost entirely in the opportunity they offer an investigator to look over the literature in *related* divisions.

For example, the physicist cannot be expected to keep posted in the classifications of mathematics, mechanics, chemistry, crystallography, psychology, and possibly

geology and others, and yet it will frequently be necessary for him to consult the cards in these subjects:

Wherein do 0330 and 0335 differ from 3205 and 3210?

Why a special section for 0345 after all the other discussions of elasticity? Compare 0360 and 1520. 0365, too comprehensive, should be sub-divided.

Why the sub-head Hardness, Friction and Viscosity?

Compare 0420 and 0550–0555–0560.

Why no conductivity of gases after 1430?

Is not 1450 superfluous; also 1580?

In 1710 and 1720 the use of 'thermal' seems ambiguous and ill advised.

Compare 1720 and 5140.

2040, superfluous.

2120 and 2210 are conflicting, and why should colloids be put in 2120?

2330 should be considerably sub-divided.

Is 3020 necessary?

3120, compare 3320.

3160 is sure to conflict with the sub-head 'interference and diffraction.'

3210 and 3215 should at least refer to 0330 and 0335.

3220 and 3225 parallel 3255.

3240 at least partly covers 3260.

3320 and 3120 interfere.

3320 quality and 3330 should go to 'sound' instead of 'sensation' and the 'voice' including 'articulation' and 'phonetics' should have a special head.

It would seem possible to improve 4000 to 4040.

5090 and 5240 conflict.

5130 and 5230 conflict.

5020 and 'reflexion and refraction' will lead to confusion.

Why is anomalous dispersion in 5350?

5460, pressure and Zeeman effect should be included.

5550, where are any reference to color, color theories and the optics of the eye? At least a reference must appear here.

6010, too brief, should have several sub-heads. As 'Ampère,' 'Ohm,' 'Farad,' 'induction,' magnetic quantities, etc.

6130 and 6140 should be under 6010. 6110 and 6240 are too comprehensive.

6305, primary and secondary should be separated.

6315 belongs under 6010.

6330, ambiguous.

6350 and 6355, much too comprehensive, each should be sub-divided in three.

6560, same comment.

6570, where are electrostatic waves?

6580, what is electro-optics? Have these phenomena not been given elsewhere?

6770, why theory of compass after all the theories in magnetics and why with the earth especially?

In specimen slips. It seems necessary to cross reference this paper to alternating fields, as it might be of interest to one investigating magnetic fields, 6560 or 6570.

William Hallock.

D. PHYSICS-MECHANICS.

In compliance with your request I beg to submit herewith the following comments on the Report of the Royal Society of London concerning the project for an International Catalogue:

1. The plan for the proposed work outlined by the report, so far as I can understand it from a necessarily hasty examination, seems to be satisfactory and feasible in all essential respects. It appears to merit, however, some criticisms as to matters of detail, which I proceed to point out with some diffidence, since the reasons which led the Royal Society's Committee to adopt the present form of their report must be partly unknown to me.

2. My first criticism relates to the 'schedules of classification,' which seem to be in some respects retrogressive.

a. Would it not be better to have the 'Registration letter' in each case the initial letter of the science?

b. The prominence given to meteorology and the incorporation of mechanics with physics seem quite unwarranted as well as archaic. The definite parts of meteorology and physics are mechanics, and the present tendency is towards mechanical interpretations of the indefinite parts. It would seem to me better to give mechanics a division by itself, or to call the proposed division Physics and Mechanics, or Natural Philosophy.

Similar, though less strong, objections may be urged against the inclusion of

anatomy with zoology, and of pharmacology and pathology with physiology.

3. The schedule of classification for pure mathematics appears quite satisfactory. Defects, if any exist, are rather trivial and relate to details of nomenclature. I would suggest, however, under 0870, p. 2, the inclusion of ‘theory of errors’ before ‘combination of observations.’

4. The schedule of classification for meteorology seems disproportionately extended.

5. The classification for physics, if it should ultimately include mechanics, ought to be rearranged in many important respects.

a. More importance should be given to pure kinematics and kinematical principles.

b. Following Thomson and Tait, dynamics should be divided into statics and kinetics; so that, for example, an entry with reference to flexible strings would indicate whether the case considered is static or kinetic, or both.

c. The entry under 0110, p. 2, for example, should be theory of force, momentum, impulse, energy and work. And under 0120, the statement should be: Principles of statics and kinetics, Differential equations of kinetics. Or, if more detail is desired, it should be: Principle of d'Alembert, virtual work, Lagrange's method, least action, Differential equations of kinetics.

d. Under 0250 there should be included the important sub-division of kinetics of plastic or non-rigid bodies.

e. Under 0515 hydrodynamical should be replaced by hydrokinetic and 0520 should read: Rotational, or vortex motion. Vortex atoms.

6. Many other criticisms concerning matters of detail with reference to the divisions of physics might be submitted. So many changes in the proposed schedule seem desirable, however, that it may be wise to submit the matter to a sub-committee of experts.

R. S. WOODWARD.

E. CRYSTALLOGRAPHY; G. MINERALOGY.

I SUBMIT the following suggestions as to the proposed schedules in Crystallography and Mineralogy:

1. The division 2000, ‘Applied Crystallography,’ I do not think a good one. It does not suggest to me the sub-divisions, and I suggest ‘Crystal Structure and Growth,’ to include 1400, 2200, 2300 and 2400 and that 2100 pass under Geometrical.

2. Under Optical Crystallography (4000) the sub-division 4200 is overworked, and the sample references on the next page show it is made to cover discussions of methods of optical measurement, like that of Wallerant. I favor, including under 4000, all optical measurements and replacing 4200, or rather supplementing it, by a division into say: Refraction in Isotropic Crystals, Double Refraction in Uniaxial Crystals, Double Refraction in Biaxial Crystals.

3. In Mineralogy I see no reason why the term General Mineralogy should cover so much. Separate divisions might well be made of (a) Microscopic Study of Minerals in Rocks, (b) Genesis and Alteration of Minerals, (c) Economic Mineralogy, (d) Artificial Minerals (or Synthesis).

I favor the plan of printing both standard sizes of card. It cannot greatly increase the expense, and will enable subscribers to choose the size already used by them. We have about 20,000 references on the smaller card.

ALFRED J. MOSES.

F. CHEMISTRY.

I HAVE read very carefully the proposed schedule of classification for chemistry of the International Catalogue Committee, and

it seems to me to pretty thoroughly cover the ground, and I do not see anything to find fault with. The only thing that occurs to me is the absence of titles covering chemical industries, but I presume they have been provided for in some other schedule. I refer, for example, to the following topics among others:

Sewer-gas	petroleum
mineral waters	illuminating gas
potable waters	mortars
water analysis	cements
sewage purification	pigments
water purification	paints
artificial illumination	varnishes
candles	preservation of timber
oils	the different explosives
lamps	glass
bleaching	ceramics
dyeing	foods, all varieties
calico-printing	preservation of food
paper-making	wines, beer, spirits
glue	vinegar
india rubber	gutta percha
fertilizers	etc., etc.

It may be that all this is provided for in some other part of your schedule.

C. F. CHANDLER.

H. GEOLOGY; J. GEOGRAPHY.

I HAVE looked over the subjects of Geology, Geography and Paleontology, as requested, in the proposed International Catalogue of the Royal Society. I feel only competent to speak of Geology authoritatively, and in this I have endeavored to imagine myself in search of literature upon almost any imaginable geological subject. The scheme impresses me in general with being a satisfactory guide in this respect, with one important omission. In almost all the important mining countries, our own especially, a great deal of attention is given to the study of what we call economic geology, or, as it is more often called abroad, applied or practical geology. I find no special topic that would cover this at all. Suppose I wished to find papers on Ore Deposits in general, or on Coal, or Building Stones, there is no topic under which these subjects would come, unless perchance it is G. Mineralogy, General Mineralogy, 0600, Applications, which seems to me an improper place for them, because they are chiefly issued by Geological Surveys or in connection with them and are geologically treated. It seems to me that in addition to the heads under H. Geology, viz: General, Petrology, Physical, Statigraphical, Maps, there should be Economics—with sub-heads—Ore Deposits in general.

Then the metals in particular—Non-Metallic Substances:

Coal	Petroleum
Building Stones	Abrasives
Salines	Fertilizers
Soils	etc.

I fancy that this sub-division of titles would be more often consulted than any other.

Under Geography and Paleontology the classification seems to me to furnish a guide that will lead one to a desired goal, satisfactorily; but I hesitate to speak positively.

There is one other general point, and that is that the scheme should fall in, if possible, with plans already established, and I do not observe that it considers the Dewey system, now adopted in an extensive bibliography of the same kind in Geology in Belgium, and issued, I believe, by the Belgian Geological Survey.

J. F. KEMP.

K. PALEONTOLOGY; L. ZOOLOGY.

WE have looked forward with great interest to the preliminary report of the International Catalogue Committee, which we understand is to be considered as a report of progress subject to future modification. It may seem somewhat unappreciative of the work that has been already done upon this report, but we must express our opinion very frankly that it is disappointing and

unsatisfactory. There are no indications that the Editors of the four Biological Divisions, Paleontology, Zoology, Botany and Physiology, have cooperated to produce a uniform scheme of treatment. On the other hand, although these sciences are in their nature closely connected, they receive an entirely diverse classification. Physiology, moreover, receives a treatment of minute sub-division which not only contrasts with the large sub-divisions of the other branches, but appears to us to be too far detailed.

The most radical fault, in our opinion, is the separation of living and extinct members in many cases of the same families and genera in the great divisions of Paleontology (including plants and animals), Zoology and Botany. This great catalogue should open a new century and signalize modern belief that living and extinct types must be considered together. It may be urged that many faunæ are wholly extinct and are studied exclusively by Paleontologists. On the other hand, no scientific line of demarcation can probably be drawn, and if living and extinct types are not studied together they certainly should be. Among the Vertebrates the separation of the living and extinct forms is at present a calamity. Zoologists must become familiar with Paleontology whether they prefer to do so or not. It is impossible, for example, to understand the modern races of dogs without studying the Oligocene races and their ancestors.

Under Paleontology the Editor proposes to give a complete catalogue of paleontological papers upon their zoological side. This would necessitate a double system of cataloguing for every paleontological paper, a needless waste of money and time.

The second radical fault, hardly less serious than the first, is the fundamentally different classification observed in Paleontology, Botany and Zoology. The Paleontological schedule is wholly unintelligible to us. It is partly Biological, partly Bibliographical. What unity is there in a system of classification which is based upon such diverse lines as are observed in 01 and 02? Where are the lines drawn between 00 and 25?

In our opinion, Paleontological classification should be identical with Zoological; it would be only necessary to add Geological distribution and to deduct cell processes; development could remain because we have considerable embryological data in extinct forms.

The Zoological classification is much better, although subject to considerable criticism in matters of detail. Why should Botanical classification differ so fundamentally from the Zoological? Modern Botany is pursued upon exactly the same lines as modern Zoology; for instance, cell processes, or Cytology, are now pursued as ardently by botanists as by zoologists.

HENRY F. OSBORN.

M. BOTANY.

THE scheme of classification adopted is not, in our judgment, as satisfactory as a decimal system would be. A number applied to a subject here means nothing definite, unless it is accompanied by a letter also, whereas in a decimal system each number would mean only one subject and could not possibly be confused with anything else.

The examples of classification of subjects indicate an attempt at too great detail, as, for instance, in the case cited 'on some new plants from Somali-land,' the attempt is made to give a detailed synopsis of contents of the article, giving names of species described with pages of publication cited, etc. Such details belong more properly to an index to systematic botany rather than to a more general index to periodical literature, which it would seem to us is all that should be attempted. Such a title as the above need

have no more than two cards, one for the author and one to be classified under Africa, with its appropriate geographic subdivision.

The method of citing volume, page and date is not at all uniform in the different divisions of the subject. We would recommend the following, which is the form used in the Index to American Literature relating to Botany, which has been in successful employment for several years and is the form commonly used by American botanists. It is further only a slight modification of the form used by the present committee in some of the sections, *e. g.*, Mineralogy.

The rules in use by American botanists are as follows:

1. All citations commence with the author (last name), followed by initials, followed by a comma, followed by the title abbreviated according to a definite uniform formula so as to be clearly distinctive.

2. Citation of journal is followed by series number (if any) in Roman, followed by a period.

3. Volume number follows in black letter (full-face type), followed by a colon, all other punctuation being periods ; this is distinctive.

4. Pages limiting the articles follow, separated by a hyphen, or, if consecutive, by a comma, *e. g.*, 314–345. 32, 33.

5. Plates and figures follow printed in italics and abbreviated as follows : *pl. 37–39.—pl. 5. f. 3.*, all separated by periods.

6. Last of all follows the date, either the year only, or, in matters where priority of publication is involved the exact date if known, the months abbreviated according to the American Library system.

A sample may be seen in the following :

GREENE, E. L., The American species of Quercus. Jour. Washington Biol. Soc. II. **13** : 223–257. *pl. 9–16.* 3 Ja 1898.

In this way the desired facts of the citation are orderly and easily noted.

The scheme under consideration seems to involve only one size of cards for the topics. As many of the larger American libraries regularly use the narrow standard cards, the slips should be capable of being printed on both standards. In the samples given, much space at the top of the card is wasted in giving the letters and numbers that designate the position of the card in the series. This is a subsidiary matter when the card is once in place and should be so printed that the title which is of prime importance should be placed as near the top of the card as possible, to facilitate ease of reference when standing on edge in its tray.

L. M. UNDERWOOD.

N. PHYSIOLOGY.

I HAVE been asked to say a word regarding the scheme of classification of physiological literature proposed by the Royal Society.

The suggested schedule is primarily and essentially a morphological one, the basis being cells, tissues, organs and organisms. In the present state of physiological investigation doubtless this is preferable to a scheme based on function alone, and the proposed scheme is comprehensive and in most respects excellent. But there is one defect that seems to me serious. There is no place for articles upon a considerable number of general physiological principles and phenomena, such as physiological division of labor, irritability, summation of stimuli, rhythm, specific energy, automaticity, fatigue, etc., etc. Many of these apply equally to cells, tissues, organs and organisms. When they are discussed with reference to specific things the articles can be classed under 05 of the respective groups. But when they are discussed simply as general principles and phenomena there is no place for them. It may be intended that they shall be placed under 'Philosophy' (0110), but such a position, under the heading 'Physiology of the Organism as a Whole,' would be only partially correct. This is the most serious omission in the proposed schedule and should not, it seems to me, be allowed to exist. It can readily be obviated by inserting between 'General

Experimental Methods' and 'Physiology of the Organism as a Whole' a new paragraph entitled 'General Physiological Phenomena,' or something similar.

Regarding one of these general phenoma a further word may be said. It has been thought best to give 'Fatigue' a special place, numbered 35, under both 'Muscle' and 'Nerve.' This is probably wise, but if it is recognized here, why not elsewhere, and why is not the same number reserved for it in other groups? Under 'Spinal Cord' 35 signifies 'Relation to Sensations'; and under 'Cerebral Hemispheres' it signifies 'Tracts of Association and Commissures.' Doubtless any scheme of bibliographical classification must be guilty of inconsistencies, but there seems no necessity for this one.

I need not emphasize that I am greatly interested in the proposed catalogue, and I trust that nothing, not even differences of opinion regarding the scheme of classification, will prevent its prompt inauguration.

FREDERIC S. LEE.

P. PSYCHOLOGY.

A SCHEME of classification for psychology has not been submitted with the other schedules. This is unfortunate, as the subject-matter of psychology and its classification require careful consideration. This can scarcely be given in Great Britain, where the science is more backward than in Germany, France and the United States. The *Zeitschrift für Psychologie und Physiologie der Sinnesorgane* and the *Psychological Review* publish annual bibliographies and the *Index* of the *Psychological Review* is republished in the *Année psychologique*. It is to be hoped that the committee of the Royal Society will consult these journals and profit by their experience. The *Psychological Index* for 1898 contains 2,558 titles, has been issued within three months of the close of the year, and is sold for $1.00. The total cost of the *Psychological Index* (500 copies) is about $250. For the book catalogue of the Royal Society's plan the cost per science with 2,500 titles is estimated at $1,700 (which does not include the real work of classification done by the regional bureaus), and the volume is to be sold for $5.00. It is by no means certain that the somewhat cumbrous machinery proposed will furnish a better bibliography of psychology than that of the *Psychological Review*, and it does not appear that psychology will profit greatly by the International Catalogue unless the card catalogue is undertaken. This I regard as far more important than the book catalogue.

While no schedule for psychology has yet been proposed, there is a certain amount of psychology in the other schedules. I do not understand why the obsolete psychological classification of physics has been partially followed. 'Theory of Wave Motion' is given as a sub-heading under 'Vibrations, Waves and Sound'. Heat with a sub-heading 'Radiation' is given earlier, while 'Light' comes later. There is given a heading 'The Sensation of Sound' under Physics, and one on 'Hearing' under Physiology. In both sciences we find, *e. g.*, a sub-heading 'Limits of Audition dependent on Intensity and Pitch.' In neither science is there a corresponding heading for Vision. Sensation and Perception should be confined to the schedule for Psychology.

J. MCKEEN CATTELL.

Q. ANTHROPOLOGY.

THE classification of Anthropology suggested in the 'Report of the Committee of the Royal Society of London' does not seem to be very systematic. It does not quite exhaust the subject-matter of anthropology, and, on the other hand, certain topics are repeated under different headings. In drawing up a schedule of this kind it

might be well to utilize the experience gained by a number of journals which have given full bibliographies of anthropology for a series of years, principally the bibliography of the 'Archiv für Anthropologie,' which has been continued successfully through a considerable series of years, and from which also an approximate estimate of the annual number of entries may be gained.

It would seem that the schedule for anthropology should correspond with the schedule of geography, of zoology, of physiology and of psychology. The numbers J 3700, J 3710, and J 3720 relate to J 3730 and J 3740, ethnography, population and race, language, customs and occupations, migration. These will be duplicated in Q. On the other hand, the topographical classification applied in geography should be applied in the schedule for anthropology.

The division Anthropometry, which is evidently meant to embrace the anthropological treatment of anatomical, physiological and psychological questions, will probably better be arranged according to the schedule suggested for zoology, physiology and psychology. It would seem that the division Races might best be replaced by the geographical division suggested in the schedule for geography.

The term 'Ethnology' is not represented in the schedule, the last seven divisions evidently being intended to take its place. The sub-division of these divisions are of very unequal scope, and the general principle underlying these seven classes is not quite consistent. This is partially true of sociology in its relation to arts, religion and administration. If the sub-divisions were carried out in the manner proposed, the number of secondary slips would become exceedingly large, probably so large as to become unwieldly. For this reason it would seem to the writer that for descriptive material a less number of sub-divisions combined with geographical sub-divisions might be used, while for ethnological discussions the geographical sub-division might be disregarded, and an exhaustive ethnological sub-division might take its place.

Franz Boas.

*THE DANGER OF INDISCRIMINATE ACCLIMATIZATION IN THE CASE OF MAMMALS AND BIRDS.**

Two events of the past year have drawn attention to the evils which are likely to follow the unrestricted introduction of birds and mammals into new localities. The attempt to expel the English sparrow from Boston Common last spring aroused unusual interest in this bird throughout Massachusetts and made many persons realize, perhaps for the first time, the extent to which it had spread in the United States. The recent acquisition of new territory has brought up the question of dealing with new pests and preventing their introduction into this country. Both Hawaii and Puerto Rico are overrun by the mongoose, one of the most destructive animals in the world, and prompt and effective measures are necessary to prevent its introduction into some of the Southern or Western States.

Acclimatization has deservedly attracted widespread interest, but too little attention has been paid to the safeguards necessary in such experiments. Animals and birds, unlike plants, are seldom kept in captivity, but are liberated in order that they may live as nearly as possible under natural conditions. Even domesticated animals may cause untold damage if allowed to run wild and increase indefinitely, as shown by the work of goats and cats which have been turned loose on islands. Animals,

*Abstract of article entitled 'The Danger of Introducing Noxious Animals and Birds,' Yearbook of the Department of Agriculture for 1898, pp. 87-110. Illustrated.

unlike plants and insects, depend on man almost entirely for their distribution from one continent to another, and, with few exceptions, are intentionally introduced. Cases of accidental distribution are confined almost entirely to rats and mice, which readily find their way to nearly all parts of the world by means of vessels. The question of preventing the introduction of noxious mammals and birds is apparently simple, and doubtless would be comparatively easy to deal with were it not for the general ignorance or indifference regarding the dangers of ill-advised acclimatization.

The mammals and birds which have thus far proved most troublesome when introduced into foreign lands are nearly all natives of the Old World. Beside cats, rats and mice, they include the rabbit, stoat, weasel, house sparrow and starling of Europe, and the mongoose and mina of India. The so-called flying foxes, or fruit-eating bats, are very destructive in New South Wales and Queensland, and are consequently a source of danger, for, although not yet actually introduced, they are likely to be carried to Hawaii and other islands in the Pacific. Some birds usually considered beneficial in their native homes are likely to prove injurious elsewhere, such as the European skylark, green linnet, black thrush, or blackbird, and the great titmouse, or ' Kohlmeise.

It will hardly be necessary to take up each of these species in detail. The history of the rabbit in Australia and New Zealand, its prodigious increase despite lavish expenditures for its destruction, and the enormous export trade in skins and canned rabbits which has recently sprung up, are too well known to require repetition here. The stoats and weasels liberated in New Zealand to kill off the rabbits have also become a pest and threaten to exterminate certain native birds. The mongoose, carried to Jamaica, in 1872, to aid in controlling the rat plague, increased almost as fast as the rabbits in the Antipodes, and, although it effectually reduced the number of rats, the advantage proved to be temporary and dearly bought. The animals increased until they spread over the whole island and became a greater pest than the rats on account of their wholesale destruction of poultry, game, ground-nesting birds of various kinds, reptiles and even fruits. The decrease of birds was followed by a marked increase in certain insect pests, but recent reports indicate that the mongoose is diminishing somewhat in numbers and some of the birds are increasing, so that both native and introduced species are adapting themselves to new conditions. In Hawaii the record is much the same, although the mongoose has not yet become quite such a nuisance as it has in Jamaica. The English sparrow was brought to America less than fifty years ago, but is now present in every State and Territory, with half a dozen exceptions, and is known as a pest to nearly every one in the eastern United States. It has begun to spread in Argentina, while in Australia it is even more troublesome than in this country. It has also gained a foothold in Hawaii and on numerous islands in the Atlantic, Pacific and Indian Oceans.

When it is considered that in nearly every case the species just mentioned were deliberately and intentionally introduced, under the mistaken idea that they were beneficial, it is evident that immense loss may result from the well-meaning efforts of thoughtless or ignorant persons, for an injurious species is likely to spread more surely and steadily than a contagious disease. The danger from such experiments is too real to be dealt with lightly and is now beginning to be realized. Cape Colony prohibits the importation or keeping of rabbits except under strict regulations.

Western Australia has absolutely prohibited the introduction of rabbits, English sparrows, flying foxes, starlings, blackbirds and thrushes, and upon the recommendation of the Colonial Bureau of Agriculture can increase the list of proscribed species at any time. California has likewise prohibited the introduction of Australian rabbits, flying foxes, or other animals or birds detrimental to fruit growing, but while she may be able to prevent the direct importation of these pests she can not keep them out if they once become acclimated in neighboring States, for they would swarm in from the north or the east as readily as the English sparrow spreads from one State to another.

The remedy is simple. Congress should take steps promptly to protect Hawaii and Puerto Rico against further introduction of noxious species and to prevent the mongoose from being brought into the United States. The introduction of exotic mammals and birds should be restricted by law and should be under the control of the U. S. Department of Agriculture. The wild rabbit, the mongoose, the flying foxes and the mina of the Old World should be rigidly excluded, and species of doubtful value, such as the starling, skylark, kohlmeise and blackbird, should be imported with the greatest care, and only in places where they can be controlled in case they prove injurious.

T. S. Palmer.

Washington, D. C.

THE MENTAL EFFECTS OF THE WEATHER.

The influence of the weather upon mental states has been a matter of comment since the days of the ancients, though but little scientific work has been done to determine, either qualitatively or quantitatively, just what the effect is. The weather maxims of wiseacres have been based very largely upon the peculiar activities of various members of the animal kingdom under definite meteorological conditions—usually those immediately preceding a storm—but, aside from these literary curiosities, material bearing even indirectly upon the subject is extremely limited. The effect of climate upon racial traits has been much more fully treated, both by the anthropologist and the criminologist, and the literature of the subject is quite extended. We are most of us, however, convinced that, whatever racial differences may be ascribed to the varying climates of different parts of our planet, we as individuals are influenced in our conduct to a marked degree by varying meteorological conditions. Literature is full of allusions to such influences, and not a few of the world's great thinkers have left on record observations of such effects upon themselves.

The study which forms the basis of this paper is an attempt to throw some light upon the problem by comparing the occurrences of certain misdemeanors and other data of conduct, under definite weather conditions, with the prevalence of those conditions. The method of its prosecution was as follows: At the New York City station of the United States Weather Bureau the mean barometer, temperature and humidity, the total movement of the wind, the character of the day and the precipitation for each one of the 3,650 days of the years 1888–1897 inclusive were copied upon specially prepared blanks. From these records were then computed, by a process of tabulation, the exact percentage of days which were characterized as fair, partly cloudy, as rainy or clear, or as having come within a definite temperature group of 5° to 10°, 10° to 15°, 15° to 20°—and, in a similar manner, within arbitrarily determined groups for barometer, humidity and wind. In this way the normal prevalence of any definite meteorological condition was determined as a basis for comparison with the occurrence of the data studied.

The latter were taken from various records available in New York City and consisted for the most part of misdemeanors under the observation of the police force of the city, the teachers in the public schools and the warden of the penitentiary, although the death record kept by the Board of Health was also considered. The total number of data considered exceeded 400,000, made up of cases of assault and battery, suicide, and arrests for insanity by the police, recorded misdemeanor in the penitentiary and public schools, record of deaths for the city, record of errors made by clerks in several of the larger national banks and record of strength tests made in the gymnasium of Columbia University. The classes of data varied in number from 1,000 to more than 100,000, and were for the years included within the period for which the weather conditions had been tabulated. By a somewhat elaborate process of computation the exact percentage of each class of data occurring under each of the definite meteorological groups was determined ; for example, the percentage on fair or cloudy days, on days when the temperature was between 15° and 20°, etc., for all the fifty or more conditions studied.

We have already stated that from the meteorological data, the normal prevalence of these conditions had been determined. It may be readily seen, however, that the normal prevalence of a condition equals the expected occurrences of each of the classes of data for that condition—for instance, if 30 % of the days for the ten years were fair we should expect 30 % of the assaults, suicides, etc., to have occurred upon fair days *if the character of the day had no influence.* If, however, 35 % did actually occur we should infer that the effect of fair days was to increase the number of assaults, as, indeed, this study has shown to be the case.

The conclusions of the paper are based entirely upon this comparison of occurrence of data under a given meteorological condition, with the prevalence of that condition. Both were reduced to percentages. When the occurrence for a given condition was found to exceed the expectancy the exact *excess* was computed and when below the deficiency. More than one hundred and fifty curves were constructed showing these relations (see 'Conduct and the Weather,' Monograph Supplement No. 10 to *The Psychological Review*), a few of which are shown with this paper.

Moderately high temperatures were found to be accompanied by excess in all the misdemeanors considered ; low temperatures by deficiencies. The temperature group 80–85° showing an excess of 68 % for assaults by males and 100 % for those by females. The next higher group, however, shows a drop to 33 % excess for the former and a deficiency of 33 % for the latter. This sudden falling-off for conditions of intense heat is shown for nearly all classes of data, and is undoubtedly due to the fact that under such temperature there is little energy available for offensive conduct. Death, suicide and the recorded error in banks alone remain excessive under such conditions.

Figs. 1 and 2 give a comparison of the occurrence of assault and death (male) referred to the temperature conditions for each month of the year. It may be seen from them that during the winter months the temperature produces but little effect, there being but slight excesses or deficiencies for any of the groups. Excesses and deficiencies read vertically. The horizontal lines show differences of 20 %, read from the heavier base lines.

When, however, we come to the spring, the higher temperature for the months are accompanied by a very marked increase in the number of assaults (April, 70–75°, an excess of 64 %) and one less marked for death. During the heated summer time

the highest temperatures do not show the greatest excesses for assaults, but the increase in the death rate is parallel with that of heat. During the unusually hot days in September and October we have about the same relation between the curves that was shown for the spring months—

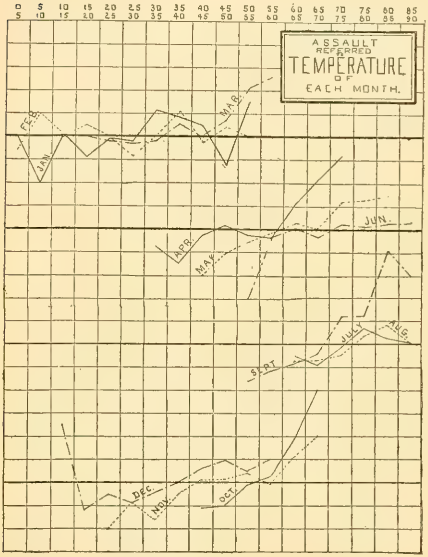

FIG. 1.

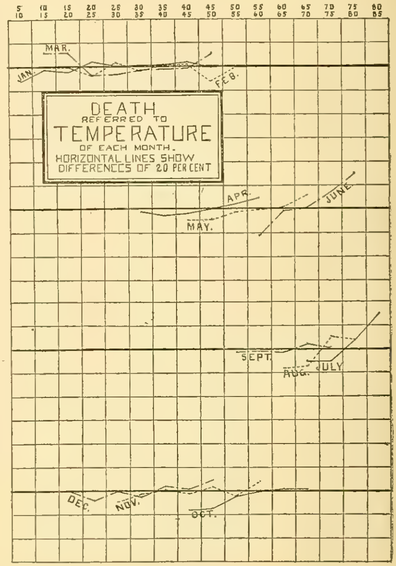

FIG. 2.

i. e., a great excess in assaults and only a moderate one in deaths. These relations are fairly conclusive, as they are based upon 36,000 assaults and 100,000 deaths.

Generalizations based upon the study of the barometrical conditions show that nearly all the data studied were excessive during low readings of the instrument. There are many reasons for concluding, however, that the actual density of the atmosphere is not the influencing factor here, but the barometrical conditions as accompaniments of other meteorological states which are themselves the effective ones—for instance, storms.

The study of humidity, in its effect upon the data of conduct gave some interesting results, since it demonstrated, beyond a doubt, that conditions of low humidity are those most productive of misdemeanor. When we consider that the muggy, sticky days on which we feel it our natural prerogative to be 'out of sorts' are of the opposite character this is quite surprising. The deficiency of disorders on such days is, however, undoubtedly due to the fact that although they are emotionally depressing they are also physically weakening, and however 'ugly' a man might feel, if energy were lacking, to be offensively active the police court is none the wiser, and the fact is lost to our study. A tabulation of profanity or even a record of the ducking stool

of colonial days might give different results. In Denver, Colorado (see also 'Conduct and the Weather'), where the humidity is normally very low, the number of misdemeanors reached an excess of more than 600% for readings between 15 and 25, which is a condition never experienced at the lower altitudes.

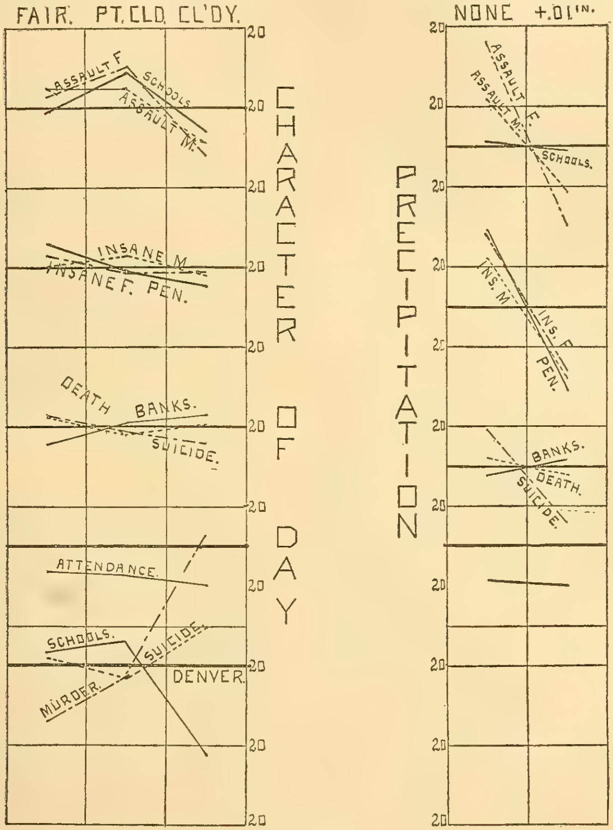

Fig. 3.

The study of the seeming effects of the wind discloses the fact that misdemeanors of the classes studied show marked deficiencies during calm (—50%) with the greatest excesses during moderately high winds and moderate deficiences again for great wind velocities. Death and suicide alone are excessive on calm days.

The state of conduct on days of different character—that is, fair, partly cloudy,

cloudy, rainy and clear—presents, I believe, a genuine surprise (see Fig. 3). This figure is to be interpreted in the same manner as the others. From it we see that misdemeanors are less frequent upon cloudy and rainy days (latter under 'Precipitation' marked '+ .01' in.) than upon those which we are accustomed to consider more agreeable. In fact, of all the classes of data studied, that for error in banks is the only one showing an opposite result. Reference to the curves shows that for assault by males (Assault M) the greatest excess occurred upon days characterized by the Weather Bureau as partly cloudy. Such days have from 4/10 to 7/10 of the hours from sunrise to sunset obscured, fair days having more than that amount of sunshine and cloudy days less.

Perhaps the most surprising curve is that for suicides, showing as it does that those who are weary of life choose the fair day, upon which there is no precipitation as the time for ending an unhappy existence. This, together with the fact that the months of May and June show the fullest record of suicides of any of the year, is directly contradictory to what seems to be the accepted opinion upon such matters. Perhaps fiction is largely responsible for the prevailing idea, and fiction would certainly lose much of its thunder if the proverbial gloomy weather could not be brought in for tragic effect. The prevailing climate may, however, influence these results, as the study for Denver (see 'Suicides' Denver upon the figure), where cloudy days are something of a rarity, their effect seems to have been more disastrous upon the suicide. There an excess of 32% is indicated for such days. The social conditions there, are, however, somewhat peculiar, as the population contains a large number of people who have gone to the region in search of health, which the sunshine was depended upon to restore, and the discouragement of even a brief deprivation of its presence was too great to be borne. Even the death rate is shown by the curves to be slightly higher during bright weather, although the difference for days of varying character is not great.

Perhaps the most interesting general conclusion to be drawn from the study is that during those meteorological states which are physically exhilarating, excesses in deportment, in the ordinarily accepted sense of the word, prevail to an abnormal extent, while death and irregularities in mental processes (error in banks) are below expectancy. During such weather conditions, without doubt the quality of the emotional state is more positive than under the reverse conditions, but the results seem to show that in the long run an excess of energy is a more dangerous thing, at least from the standpoint of the police court, than the worst sort of a temper with no energy.

Edwin G. Dexter.

SCIENTIFIC BOOKS.

SOME RECENT WORKS ON MECHANICS.

Theoretical Mechanics, An Introductory Treatise on the Principles of Dynamics, with Applications and Numerous Examples. By A. E. H. Love. Cambridge, At the University Press. 1897. 8vo. Pp. xv + 379.

Vorlesungen über theoretische Physik von H. von Helmholtz. Herausgegeben Von Arthur König, Otto Krigar-Menzel, Franz Richarz, Carl Runge. Band I., Abtheilung 2. Die Dynamik discreter Massenpunkte, herausgegeben von Otto Krigar Menzel. Leipzig, Verlag von Johann Ambrosius Barth. 1898. 8vo. Pp. x + 380.

One of the most original and suggestive of recent works on theoretical mechanics is the treatise on dynamics of Professor Love. The merits of this important book arise naturally from the author's point of view, and we are prepared to expect something more than stereotyped forms on reading in his preface that "The works which have been most useful to me in

connection with matters of principle are Kirchhoff's Vorlesungen über mathematische Physik (Mechanik), Pearson's Grammar of Science, and Mach's Science of Mechanics. This last should be in the hands of all students who desire to follow the history of dynamical ideas.'' We are still more interested to examine the book when we read in the introductory paragraph that "Mechanics is a natural science; its data are facts of experience; its principles are generalizations from experience. The possibility of natural science depends on a principle which is itself derived from multitudes of particular experiences—the 'Principle of the Uniformity of Nature.' This principle may be stated as follows: Natural events take place in invariable sequences.''

From this classification of mechanics along with the natural sciences one may correctly infer that the work is more concerned with the facts than with the formulas of the subject. Indeed, the old notion, still held by many, that mechanics is simply a branch of applied mathematics whose data are as unquestionable as the data of Euclidean geometry, finds no tolerance here. On the contrary, one of the most important features of the work consists in its critical examination of the postulates and principles of mechanics and their range of applicability to matter as we know it. The doctrine of relativity of motion, force, etc., so generally overlooked or ignored in works on dynamics, is here considered with much particularity; well-known results are presented in clearer lights, and many new or less well-known results are to be found in every chapter. In short, the work is a thoroughly progressive and instructive treatise which will bring pleasure and profit to any energetic student of mechanics.

The book is divided into three parts embracing in all thirteen chapters. The first part, including the first four chapters, deals with kinematics; the first chapter being devoted to definitions, the second to vectors, the third to displacement, velocity and acceleration, and the fourth to applications of kinematical principles. A novelty of nomenclature introduced here with apparent advantage is the word 'frame,' or the phrase 'frame of reference,' in place of 'axes' or 'coordinate axes,' though one may doubt the desirability of such a change of terms unless it can be made in other applications of coordinate geometry as well.

The second part, Chapters V. to VIII., is devoted to the principles of dynamics. Herein there is a notable departure from the plan of treatment followed in most English texts. There is less of the appearance of formal deduction and more of the reality of simple induction. This method leads, by an appeal to observation and experiment, to the essential concepts of mass and force, and thence to the equations of motion of a free particle. The laws of motion of Newton are not incorporated in the text, but are commented upon in a note at the end of Chapter V. General theorems concerning the motions of masses are considered in Chapter VI.; systems of forces are treated in Chapter VII., and Chapter VIII. is devoted to work and energy. A new and commendable term, namely, 'kinetic reaction,' appears in this part for the first time, apparently, in a text-book. This may well replace the 'expressed force,' 'force of inertia,' etc., of earlier writers. A critical note at the end of Chapter VIII. is well worth examination by advanced students of the science.

The third part of the work, Chapters IX. to XIII., deals with methods and applications. These cover about 120 pages, and a large variety of solved and unsolved problems is set before the reader. Chapter IX. is occupied with free motions of particles, X. with constrained motion, XI. with coplanar motions of a rigid body, XII. with miscellaneous methods, and XIII. with relative motion and gravitation. Much space is given in these chapters to impulsive motions and to the intricate questions of initial motions, and a considerable portion of Chapter XII. is devoted to the interesting subject of the motions of strings and chains. A short appendix deals with the questions of units and their dimensions.

The work appears to be subject to the following minor criticisms: Too little space is given to kinetics in three dimensions. On p. 96 there is a definition of the law of gravitation which will lead the incautious reader to adopt the common but erroneous notion that the gravitation constant is a mere number, that is, a quan-

tity independent of the units of length, mass and time. And this leads to the remark that in didactic treatises it is best for the author as well as the student to make constant use of the theory of dimensions. On pp. 258, 260, 262, we find the phrase 'impulsive pressure' used as a synonym for momentum and impulse. This is plainly a slip of the pen, since the equally objectionable 'impulsive force' of the older writers finds no favor with the author. Here again, and also in the phrase 'angular momentum,' which the author seems to sanction as the equivalent of 'moment of momentum,' the theory of dimensions points the way to precision of terminology. Lastly, a book so full of excellencies should have a much fuller index, some comparatively new terms like dissipative forces, motional forces and positional forces being omitted or given only indirectly, and the important name of Mach being overlooked altogether.

With commendable admiration for their great master, the editors of the series of volumes to which the one before us belongs have undertaken to present in printed form the lectures on mathematical physics delivered by Helmholtz in the later years of his life. In doing this they are doubtless fulfilling a pious duty, but they are also assuming a serious task, for no one short of a master is fitted to elaborate the lectures of a master. As regards the present volume, on the dynamics of discrete particles, the task of the editor was not specially difficult, since the subject has been pretty thoroughly wrought out during the past two hundred years. In fact, much of the matter in this volume would not be worth publishing at all in such a series if it did not possess here and there the impress of the master's originality.

The book is divided into four parts. The first part deals with the kinematics of a point, the second with the dynamics of a material point, the third with the dynamics of a material system, and the fourth is devoted to the general principles of dynamics, including statics as visualized in the principle of virtual displacements, and the methods of d'Alembert, Lagrange and Hamilton in kinetics.

The first part presents little that is novel, and is quite insufficient for the needs of anything beyond elementary work in kinematics. The most important theorems of the subject are not even alluded to. The second part establishes the equations of motion of a free particle by the aid of Newton's laws, and devotes an undue amount of space to the simplified case of a 'falling body' without disclosing anything of its essential complexity. Then follow seventy-seven pages treating of oscillatory motions, including simple harmonic and damped vibrations and the theory of the simple pendulum moving in a plane or cone. Much of this space is rather dreary in its prolixity, but the physicist will find the sections treating of damped vibrations and forced vibrations well worth reading.

The third part sets down the equations of motion of a system of masses by aid of the principle of equality of action and reaction whereby the internal forces of the system are seen to be self-balancing. Then follow the well-known theorems concerning the motion of translation of the centroid of the system and of its rotation about axes through the centroid. The notation used here is needlessly complex; but the following section, which deals with the very important subject of moments of inertia, is rendered repulsive by reason of a violent and quite useless departure from current notation. Why should a subject so old (dating from Segner and Euler) and so intrinsically difficult be encumbered by a strange notation when nothing new is presented?

The remainder of the third part is devoted to the principle of energy and to an elementary presentation of the theory of planetary motion. The forty pages allotted to the doctrine of energy are chiefly interesting for their historical matter and for the author's physical conceptions, while the thirty-six pages in which Newton's problem of two bodies is treated afford an easy introduction to dynamical astronomy.

For the advanced student of mechanics the fourth part of the book will be found most interesting and instructive. It is in this part that the editor presents the author's latest views on the generalities of the science. There is not much herein that is new; but the student

who is unacquainted with Helmholtz's modes of thought will find it well worth the effort essential to master the connected exposition here given of the comprehensive methods of d'Alembert, Lagrange and Hamilton. Many readers will encounter a difficulty in an unusual and, apparently, an unhappy notation, considering the precedents set long ago by Lagrange. Those to whom English is the mother tongue will also be pained at the ease with which the old and the new terminologies are mixed. But these are minor matters in comparison with the clear physical concepts and the penetrating analytical processes which characterize the work of the great author. This last part, which comprises a little more than one-fourth of the bulk of the book, is divided into four chapters. The first of these treats of statics from the point of view of virtual displacements and as the vanishing case of kinetics. The second treats of kinetics, giving especial attention to the equations of d'Alembert, Lagrange and Hamilton, the author's well known preference being expressed for the Hamiltonian form of equation. The third chapter deals with the applications furnished by rigid bodies, including the theory of the top and the theory of terrestrial precession in their elements. The last chapter is devoted to the application of dynamical principles to non-conservative systems. It is especially noteworthy for certain reciprocal relations (Reciprocitätsgesetze) shown to hold between pairs of partial derivatives of the external forces with respect to the corresponding velocities and accelerations, several important physical applications of these relations being cited.

R. S. W.

Social Phases of Education in the School and the Home. By Samuel T. Dutton, Superintendent of Schools, Brookline, Mass. New York, The Macmillan Company. Pp. viii+259. Price, $1.25.

This volume consists of "lectures given during the past two years at Harvard, Chicago and Boston Universities, and papers read before the American Social Science and the National Educational Associations." The author says that "the point of view is in all cases social rather than scholastic, and the ideas emphasized are as worthy of consideration by parents as by teachers." Indeed, the chief value of the book is that it gives a popular interpretation of some current ideas in educational thought. Teachers of all grades will find it helpful and stimulating, and there is enough sound educational theory at the bottom to make it a safe guide to parents.

Mr. Dutton takes as his thesis the idea that the school is a form of social life. Its purpose is to minister to the support of the home and to render service to human society, or to socialize the youth and to fit him to take his place in society and to render the best service of which he is capable. In the thought that "the object of the school is to socialize the child, to make him acquainted with his environment and conscious of his obligations to others," is to be found the clue to Mr. Dutton's educational practice. He believes in emphasizing the 'preparation for vocation' as an aim of the school, because he believes in work—that 'useful activity' which best conserves 'man's physical, moral and spiritnal welfare.' He believes in 'general culture,' the kind that fits one to live more efficiently and helpfully day by day, the kind that makes one a better man or woman and renders one more serviceable. With this idea in mind he looks upon the old school curriculum as meagre and narrowing; he advocates more of physical and manual training and of the domestic and fine arts, "not only because they touch the elemental wants of mankind, but because they connect the school and the home, create a close sympathy between parents, teachers and pupils, and tend to level up whole communities where the less fortunate reside." As for other studies the criterion of excellence must always be the part they play in human life and the service they render to society. This social aim even determines the methods to be employed in teaching—"the governing principle of the recitation should be, not competition, but cooperation;" it should enter into the home life and the management of children in school—"thus, every pupil becomes actively interested not only in being courteous, orderly and helpful himself, but in having his associates combine with him in this social effort." For this reason

the author advocates some form of self-government in home and school, the cooperation of church and school in educational work, the correlation of educational forces in the community, and in the closing chapter he very properly gives an account of the Brookline Education Society and its work—a work in which Superintendent Dutton may well take pride. * * *

Who's Who in America? A Biographical Dictionary of Living Men and Women of the United States, 1899–1900. Edited by JOHN W. LEONARD. Chicago, A. N. Marquis and Company. Sm. 8vo. Pp. xxxii + 822. Price, $2.75.

Under the somewhat flippant title borrowed from a useful English publication, Mr. Leonard and his publishers have put forth a notably compact, convenient and scholarly hand-book, at once an autobiographic cyclopedia and a directory of eminent living Americans. The biographic sketches are models of symmetry and condensation, and may be accepted as trustworthy, since the information in nearly all cases was obtained from the persons themselves or from their families, frequently through repeated effort and prolonged correspondence. The delicate and difficult task of selection, or of assorting the 8,602 eminents out of the seventy-odd millions of residuary population, seems to have been performed with great discrimination and fairness, with the assistance of a considerable corps of advisers in special lines of activity. The dictionary-directory is supplemented, and its scholarly air enhanced, by introductory chapters on 'Educational Statistics' and 'Birth and Residence Statistics,' which are real contributions to knowledge of national characteristics; and there is an extended 'Necrology,' in which are listed prominent men and women of America deceased since July 1, 1895. The book-making is admirable for the purpose; the volume is convenient in size and form, distinctive and serviceable in binding, suitable in paper, and well-adapted in typography; while the proof-reading is, in view of the predominance of proper names, remarkably good—the critic for *The Nation* notes but a single error. So, on the whole, the book is as comfortable as it is necessary to those who wish to know something of their contemporaries. The handbook ought to be particularly helpful to scientists and educators, partly as an up-to-date directory, partly because it gives prominence to distinction in their lines of intellectual activity, perhaps more satisfactorily than any other biographical work extant. Among the few categories of eminents introduced on arbitrary lines are all members of the National Academy of Sciences, and all heads of the larger universities and colleges; and examination of the pages indicates that fully a thousand eminents, or an eighth of the whole, are distinguished for original investigation, frequently combined with teaching, while something like half as many more come in as educators alone. The inclusiveness of the book, as regards scientific men, is indicated by the proportion of entries to the editorial corps of our leading journals of investigation, selected nearly at random: *e. g.*, of the twenty editors and associate editors of SCIENCE, and of the eleven of the *American Journal of Science*, all appear in the book; of the ten editors of the *American Anthropologist*, all appear except the one foreign member of the board; of the editorial corps of the *National Geographic Magazine*, twelve out of thirteen appear, and of that of the *American Geologist*, eleven out of twelve; while twelve out of the fourteen American editors of the *Journal of Geology* find place. The educational tabulation is especially suggestive, and the fact that fully half of the eminents were educated in universities and colleges arises as a new argument for thorough education. The distribution of eminence, too, is of much interest. Naturally New York (State) stands first, with 2,039 or twenty-four per cent. of the whole; Massachusetts and the District of Columbia follow almost together, the former with 742 and the latter with 724; Pennsylvania holds fourth place with 622, closely approached by Illinois with 564; then there is a considerable drop to Ohio with 321, followed by New Jersey in the seventh place with 296; then come California with 210, Connecticut with 193, and in the tenth place Missouri with 171; the remaining States with quotas exceeding 100 are Michigan, 144; Mary-

land, 142; Minnesota, 125; Iowa, 121; Indiana, 111; Wisconsin, 108; Tennessee, 105, and Virginia, 102. The comparison between birthplace and present location is equally interesting, illustrating as it does the westward drift, the concentration in States of large cities, and the disadvantage of foreign birth in the race for accomplishment. No occasion for criticising the book appears, though it may be suggested that its convenience might be increased in future editions by printing both the ordinary form of writing the name and the full forename in parentheses, after the manner adopted (but afterward abandoned on pecuniary grounds) by the Joint Commission of the Scientific Societies of Washington, thus: Gordon, Professor J. C. (Joseph Claybaugh). But even without this refinement, the book is admirably complete and convenient.

W J M.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for August contains the following articles:

Rotatory Polarization of Light in Media subjected to Torsion, by A. W. Ewell.

Lichenaria typa W. & S.. by F. W. Sardeson.

Studies in the Cyperaceæ, XI., by T. Holm.

Constitution of Tourmaline, by F. W. Clarke.

Determination of Tellurous Acid in presence of Haloid Salts, by F. A. Gooch and C. A. Peters.

Iodometric Method for the Estimation of Boric Acid, by L. C. Jones.

Method for the Detection and Separation of Dextro- and Levo-rotating Crystals, with Some Observations upon the Growth and Properties of Crystals of Sodium Chlorate, by D. A. Kreider.

Devonian Interval in Northern Arkansas, by H. S. Williams.

Note on a New Meteoric Iron found near the Tombigbee River, in Choctaw and Sumter Counties, Alabama, U. S. A., by W. M. Foote.

Orthoclase Crystals from Shinano, Japan, by C. Iwasaki.

SOCIETIES AND ACADEMIES.

BOTANICAL SOCIETY OF AMERICA.

THE fifth annual meeting of the Society will be held in Columbus, Ohio, August 18 and 19, 1899.

The address of the retiring President, Dr. N. L. Britton, upon the subject: 'Report of Progress of Development of the New York Botanical Garden,' will be given in the Chapel, University Hall, Friday evening at 7:30 o'clock. The lecture will be illustrated with lantern views. On the following day, Saturday, the regular sessions for the reading of papers will be held in Room 17, Townshend Hall, at 10 a. m. and 2 p. m. The following papers are already announced for the meeting, and others are to be expected when the full program is made up by the Council.

'Apetaly and Diœciousness,' Charles Edwin Bessey.

'The Spore Mother Cells of Anthoceros,' Bradley Moore Davis.

'Symbiosis and Saprophytism,' Daniel Trembly MacDougal.

'The Effect of Centrifugal Force upon the Cell,' David Myers Mottier.

'The American Species of Arisæma,' Nathaniel Lord Britton.

'The Uredineæ occurring upon Phragmites, Spartina and Arundinaria in America,' Joseph Charles Arthur.

'Some notes upon Distribution of American Erysipheæ,' Byron David Halsted.

'Gametes and Gametangia of the Phycomycetes,' Bradley Moore Davis.

The first meeting of the Council will occur at 2:00 p. m., at the Chittenden Hotel, and the first business meeting, according to custom, at 4:00 p. m., in Townshend Hall, Room 17. A business meeting for the election of officers and new members and for the transaction of other business will be held at 9:30 a. m., Saturday.

GEO. F. ATKINSON,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ANAGLYPHS AND STEREOSCOPIC PROJECTION.

AFTER an enthusiastic period some twenty odd years ago the interest in stereoscopic views suffered a reaction. The interest has been lately reawakened in many ways. In SCIENCE Professor Jastrow has already discussed some stereoscopic methods; in SCIENCE for July 14th of this year Mrs. C. Ladd Franklin makes special mention of pictures printed in two colors and urges the adoption of a method of stereoscopic projection. The following account may, perchance, contain some minor bits of information not already well known.

1. The color method of printing stereoscopic pictures was invented by L. D. du Hauron, of Algiers. Two blocks, *e. g.*, half-tone plates, are made from a pair of pictures taken in the usual way with the stereoscopic camera. The picture taken with the right-hand lens is printed in red ink on paper, that with the left-hand lens in blue ink directly over it. The result is a blurred picture. When this blur is viewed through a pair of spectacles consisting of blue glass for the right eye and red glass for the left eye the two pictures reach the eyes separately and appropriately. This occurs because to the eye looking through the blue glass the white paper and the blue printing appear—practically—an even blue background, while the red appears as a black picture; similarly, to the eye with red glass the blue print appears as a black picture on a red ground. These two pictures, reaching the brain separately, are there combined into a picture in three dimensions showing apparently a solid view in wavering purple light. The peculiar wavering light is the result of fluctuating binocular mixture and binocular strife.

The pictures have been sold as 'anaglyphs' for a number of years by the Comptoir Suisse de Photographie at Geneva. A few years ago they were sold by a Philadelphia agent and were marked 'Patent 8,20,95.' This is the patent-grant 544,666 of August 8, 1895, which states that the article was patented in France in 1891.

A peculiar effect arises from twisting the picture or the head while observing these pictures; the objects in the relief figure appear to move relatively to each other.

2. The projection of stereoscopic pictures by a double lantern is not so unknown in America as Mrs. Franklin supposes. In the fall of 1895 I had occasion to deliver a public lecture on vision and, not knowing how to do anything with binocular vision without some such method, I hit upon the idea of throwing the two parts of stereoscopic views on the screen in red and green lights and giving bits of red and green glass to the audience. The method proved a complete success at a lecture in the Brooklyn Institute. Since then it has been in regular use in my laboratory for studying the laws of binocular vision. I have, however, no claims to credit for the fundamental idea of the method. Some photographer seems to have previously projected two pictures in a similar way; the details of his process have not been accessible to me. The whole method was described and various technical hints were given in the *Scientific American*, 1895, LXXIII., 327. This method is now used by several colleges. A Philadelphia firm (Williams, Brown & Earle) is preparing to furnish the materials and a carefully selected set of slides to illustrate scientific and educational subjects. The equipment is so inexpensive for any one possessing a double lantern that the cost is hardly worth considering.

3. There is still another method of stereoscopic projection which is in some ways superior to the red-green method. The two pictures are thrown by two beams of white light, polarized at right angles, on to a corrugated silvered screen and are viewed by an eye glass composed of two analyzers at right-angles. As the inventor of this method, John Anderton, of Birmingham, England, was kind enough to donate a complete outfit to the Yale Laboratory, we have had the opportunity to use it regularly for instruction. The method is superior to the red-green method in projecting both pictures in white light, and the cost is not excessive. A complete description of it has been given in my 'New Psychology,' p. 423.

4. It may be technically justifiable to call the results of stereoscopic union by the term 'pictures in three dimensions,' but it is psychologically incorrect. The view seen by stereoscopic projection is—to the observer—the real thing. There is no picture effect about it when the thing is properly done; the relief and solidity of the objects appear just as real as in the case of real objects. Of course, it is physically impossible to have a group of exotic palms where the screen and lecture table were standing a moment ago, and the group seen lacks coloring. These factors give a slight unreality to such a stereoscopic view; the observer feels as though he were looking at a model. In the case of statuary or other objects where color is lacking or subordinate the reality is perfect; to

the observer ten feet or more from the screen there is no inferiority in the sensation he receives. In the case of ordinary stereoscopic views the reality is lessened by the small size; an ordinary view looks like a view into a model, but a view in life-size is a real matter. Curiously enough, a view larger than life-size is singularly impressive and fascinating.

The advantage is surely very great in getting a whole museum of statues or of natural history specimens, in keeping the collection in a single case, and in being able to show them at any moment by merely turning on the switches or stop-cocks of a double lantern.

E. W. SCRIPTURE.

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POT-HOLE VS. REMOLINO.

TO THE EDITOR OF SCIENCE: Something more than formal advocacy of a word is usually necessary for its adoption; it must survive by its own fitness. In so far, however, as individual recommendations may have weight I may say that I am in favor of Mr. O. H. Hershey's suggestion that the word remolino be used in place of pot-hole.

The objections to the use of the word remolino raised by Mr. F. F. Hilder in SCIENCE of July 21st do not seem to me to be well founded. Is it true that "the term pot-hole expresses the object to which it is applied more correctly than the Spanish word?" While the term may have been applied on account of the shape of the holes, it is more likely that it gained its use from a common belief that the holes were excavated by the Indians for cooking purposes. If this be the case the word pot-hole is more misleading than remolino, for the latter, at least, gives a correct suggestion as to the way in which the holes have been formed.

Again, in which sense can it be said that the word remolino is incorrectly used by the people of Colombia? Are such words as villain, charity and many others incorrectly used by us because we do not employ them in their original significance? Had the compiler of the Spanish dictionary in which Mr. Hilder sought the definition of the word remolino known of its use by the people of Colombia as a name for a rounded rock cavity made by an eddying current of water he would probably and very properly have given that in his list. Would the critic of nomenclature have then thought it incorrectly used?

OLIVER C. FARRINGTON.

FIELD COLUMBIAN MUSEUM, CHICAGO.

NOTES ON INORGANIC CHEMISTRY.

AN interesting paper on the cause of color in minerals by L. Wöhler and K. v. Kraatz-Koschlau has appeared in *Tschermak's Mitteilungen*. While many minerals are colored by organic substances, the quantity is too small for identification. In several cases, as in zircon and smoky quartz, the presence of nitrogen was proved, and from bases in celestine from Gembeck three different double platinum salts were obtained. Contrary to the view of Nabl, the coloration of amethyst is not due to ferric thiocyanate, as no sulfur is present.

The difficulty of identifying the inorganic coloring materials of minerals is no less than that of organic; indeed, it was found necessary to use synthetic processes exclusively. Chromium is the cause of color in many minerals. In the case of chrome garnets, chrome spinel, chrome diopside this is apparent, but is no less true in red and violet spinel, ruby, sapphire, oriental amethyst, green zircon and topaz from Villarica. It was not found possible to detect the chromium in ruby and sapphire, but on fusing alumina and barium fluorid with one-fifth per cent. of potassium bichromate the crystals of alumina obtained were chiefly colorless, but red, blue, yellow and green crystals were also found. From the color differences it is probable that the chromium is present in different oxydation stages. It was not found possible to color alumina by iron, even at very high temperature. In the Villarica topaz no trace of manganese was present. Wulfenite and vanadinite are also probably colored with chromium, though organic matter is also present. While titanic acid, and hence pure rutile, is colorless, the sesqui-oxid gives a dark brown color; hence the color of ordinary rutile is due to partial reduction of the titanic acid, a red tint being in part due to the presence of iron. The color of chrysoprase is due to the presence

of some organic compound of nickel. The color of the yellow barite of Cumberland is caused by a hydrated ferric oxid. While some of the conclusions of the article may not be as certain as the authors believe, it is one of the best worked-out papers which has appeared on the subject.

A CAREFUL study of the precipitated sulfids of antimony is given by Otto Klenker in the *Journal für praktische Chemie.* The precipitate by hydrogen sulfid from solutions of quinquivalent antimony varies in color from light or dark brown to red and orange; from acid or neutral solutions it is flaky, settles easily and when dry is electric and not hygroscopic; from alkaline solutions it is fine and does not settle, when dry is very hygroscopic but not electric. Its composition is always variable, being a mixture of Sb_2S_5, Sb_2S_3 and free sulfur. From a strongly alkaline solution no Sb_2S_5 is precipitated, but this increases until a maximum of Sb_2S_5 (over 95%) is present when the solution contains 12% free hydrochloric acid. If the acid increases above this the amount of Sb_2S_5 diminishes owing to its solubility in strong hydrochloric acid. In a hot acid solution no Sb_2S_5 is formed, differing thus from quinquivalent arsenic solutions which are completely precipitated as As_2S_5 from hot acid solutions. When the mixed precipitate of antimony sulfids and sulfur is dissolved in caustic soda the reaction for trivalent antimony is not given with ammoniatal silver solution, as the alkaline solution of mixed Sb_2S_3 and S_2 acts as Sb_2S_5. On the other hand, if the free sulfur is previously removed with carbon bisulfid the reaction is obtained. Sb_2S_5 is, however, not decomposed appreciably under 100° by carbon bisulfid or any other solvent of sulfur.

PAUL BOURCET has proposed in the *Comptes Rendus* a new method for the estimation of iodin in organic matter, which consists in fusing the substance with caustic potash, neutralizing with sulfuric acid and freeing from other salts by repeated precipitations with alcohol. The iodin is liberated in the presence of carbon bisulfid by nitrous acid vapors and estimated colorimetrically. The quantity of iodin in a large number of different kinds of fish was determined and found to vary from nearly two milligrams per kilo in *clupea harengus*, and 1.4 mg. in *salmo salar*, down to 0.3 mg. in *merlangus vulgaris*, *scomber scombrus*, *esox lucius*, 0.2 mg. in *raia clavata*, and 0.1 mg. in *truita marina*.

IN the course of investigations on the effect of low temperatures upon steel it has been found by F. Ormond that nickel steels, if non-magnetic to begin with, acquire magnetic properties after five minute's immersion in liquid air. If most of the nickel is replaced by manganese the same is true. Carbon steel with 1.4 to 1.6 per cent. carbon, after being immersed in liquid air and then brought back to ordinary temperature, is found to be profoundly modified. There is an increase in magnetic permeability and in permanent magnetism, and the density is decreased from 7.798 to 7.692. The polish upon a surface disappears.

J. L. H.

BOTANICAL NOTES.

SPRUCE AND PINE FORESTS OF WEST VIRGINIA.

IN an interesting bulletin (No. 56) of the West Virginia Experiment Station, Professor Hopkins reports the results of an investigation of the cause of the unhealthy conditions of the spruce and pine of that State, and incidently gives us a good deal of information regarding its spruce and pine forests. The spruce (apparently *Picea rubens* Sargent) is a tall, straight tree, two to three feet in diameter, and more than one hundred feet in height. It is abundant at and above 3,000 feet above sea level, and is seldom found below 2,300 feet, and reaches its highest development in the region about the headwaters of the Cheat, Valley, Greenbrier, Elk and Gauley Rivers. In this region it commonly grows on a soil which is described as "little else than a mass of broken stones, which is literally filled with water at all seasons of the year." After studying the problem carefully, Professor Hopkins concludes that the area originally covered by spruce forests included all of the higher elevations of the Appalachian range that rise above 2,400 feet, or, in other words, about 2,000,000 acres, and on this area 'one-half of the timber was probably spruce.' The author discusses the reduction of this original forest area, and concludes that "the

total merchantable spruce timber now standing would not be equivalent to much over 225,000 acres of pure spruce forests, averaging 15,000 feet of lumber to the acre."

The pines of the forests of the State are five in number, as follows: White Pine (*Pinus strobus*), widely distributed over the State; Yellow Pine (*Pinus echinata*), in the eastern, southern and western sections of the State; Pitch Pine (*Pinus rigida*), widely distributed over the State; Scrub Pine (*Pinus virginiana*), growing where other pines will not thrive; Table Mountain Pine (*Pinus Pungens*), common in old highland fields and on the mountains and foothills of Hampshire, Grant, Mineral and Pendleton counties. "It is evident," the author says, "from available records and present indications that at one time, possibly not later than 250 years ago, the predominating forest trees over large areas in the southwestern third of the State, as well as in the southern and eastern sections, were pine, and that the isolated forests, and the groups and individuals of the white, yellow, pitch, scrub and table mountain pines that we find at present, are living examples and lineal descendants of extensive primitive forests of one or more of the species mentioned." As illustrating the rapid destruction of the forests, the author says, further: "In the present pine areas of the State I would judge that ninety per cent. of the merchantable pine timber has been removed or has died."

STUDIES OF THE SPECIES OF EUPHORBIA.

IN a recently published paper issued by the Missouri Botanical Garden, Mr. J. B. S. Norton revises the North American species of *Euphorbia* of the Section *Tithymalus* occurring north of Mexico. No general work on the North American species of the Section *Tithymalus* has appeared since Boissier's monograph of the genus as a whole in De Candolle's 'Prodromus,' published in 1862, although a number of new species have been described. Engelmann, and recently Millspaugh, studied the genus in this country, but the section under consideration sadly needed revision at the time Mr. Norton took it up, two and a half years ago, at the suggestion of Dr. Trelease. As a result of Mr. Norton's studies, we have here an arrangement and description of thirty-six species and twelve varieties, accompanied by forty-two well-drawn plates. It is encouraging in these days of species-making to find that although the author is working over a group which has not undergone revision for thirty-seven years he separates but one new species! When it comes to varieties he is able to get along with but seven new ones, and he calls them *varieties* and not *species*. Such caution in the treatment of species and varieties is to be most heartily commended, and we should be glad to see much more of it in the work of monographers. The author follows Boissier's system of classification with little modification, and appends a diagram showing his ideas as to the relationship of the species. He makes no attempt to revise our notions as to the morphology of the flowers and flower-clusters, accepting these as ordinarily treated in standard works.

BOTANY IN IOWA.

THE Sixth Volume of the Proceedings of the Iowa Academy of Sciences (1898) contains nine botanical papers, as follows: 'Preliminary Report on the Diatoms of Iowa,' by P. C. Myers, being a general paper on collecting these plants; 'Report on a Fossil Diatomaceous Deposit in Muscatine County, Iowa,' by P. C. Myers, cataloguing fourteen species; 'Diatomaceous Earth in Muscatine County,' by J. A. Udden, describing the locality of the preceding deposit; 'Forest Trees of Adair County, Iowa,' by J. E. Gow, illustrated by a map, and including a catalogue of thirty-one species, several of which are mere shrubs, as Dogwood (*Cornus paniculata*), Sumac (*Rhus glabra*), Elderberry (*Sambucus canadensis*), Hazel (*Corylus americana*), Wild Grape (incorrectly given as *Vitis Aestivalis* instead of *V. vulpina* of Linnæus, or *V. riparia* of the older manuals); 'Effects of a Sleet Storm on Timber,' by J. E. Gow, accompanied by photographs of injured trees; 'The Iowa Liverworts,' by B. Shimek, giving a list of twenty-one species; 'A Preliminary List of the Mosses of Iowa,' by T. E. Savage, being an annotated list of seventy-eight species; 'Additions to the Bibliography of North American Lichens', by Bruce Fink, including ninety-five titles; 'The Flora of

Southern Iowa,' by T. J. and M. F. L. Fitzpatrick, including a catalogue of several hundred species of flowering plants and ferns.

Charles E. Bessey.

University of Nebraska.

THE SCHOOL OF GEOGRAPHY AT OXFORD UNIVERSITY.

The recent founding of a School of Geography at Oxford University is an event of more than passing interest to the educational and scientific world, and deserves a word of comment on this side of the water. The Royal Geographical Society has long deplored the lack of opportunity for geographical training in Great Britain and has been endeavoring to get geography properly recognized in both university and school. Over fifteen years ago the present Secretary of the Society, Dr. J. Scott Keltie, made a careful study of the status of geography teaching in the schools of Great Britain, and published a complete report that has been of great and permanent value. For the last few years readers have been maintained in Geography at both Oxford and Cambridge, largely through the efforts of the Society. At the same time, at the Society's rooms, training has been giving to prospective travellers in the art of surveying and in the other scientific lines of value to all explorers. The success of these various lines of work has led to the establishment of the School at Oxford, under the joint auspices of the Society and the University. Each institution will contribute £400 annually, and the management of the School will be vested in a committee, consisting of the Chancellor *ex-officio*, of three nominated by the Council of the Royal Geogragraphical Society and three nominated by the Delegates of the Common University Fund.

The School will start with a staff of four members, consisting of the present Reader, Mr. H. J. Mackinder, M.A.; the Assistant to the Reader, Andrew J. Herbertson, Ph.D.; a Lecturer in Physical Geography, Mr. H. N. Dickson, F.R.S.E., and for the year 1899–1900 a Lecturer in Ancient Geography, Mr. G. B. Grundy, M.A.

The work of the School will include a course in systematic instruction primarily intended for graduates and other advanced students, with demonstrations and practical work in physical geography, cartography and surveying. Courses of lectures will also be given with special reference to the historical and scientific teaching in the University.

Sir Clements Markham, in his annual address to the Royal Geographical Society, spoke at length in reference to the project and outlined a large field of results to come from the increased opportunities in geographical training. He particularly emphasized the fact that the School would be open to all, whether attached to the University or not.

It is to be hoped that the enterprise may succeed abundantly, and certainly it is fitting that the leading commercial nation of the world should undertake to give its young men training in an important branch of education, whether in preparation for business or political life. The importance of geography in commerce has long been recognized by certain leaders in Great Britain, but the necessary steps for bringing about commercial progress through increased geographical training have been too long deferred. This School is the only one in Great Britain and should fill a long standing need. With the opportunities at Bruxelles and at Oxford, both of which have recently been established, geography has received a recognition that ought to be a lesson to this country, especially to the authorities of our many large universities that have no chairs in this science.

R. E. D.

SCIENTIFIC NOTES AND NEWS.

Details have reached us in regard to the approaching meeting of German men of science and physicians, which will be held at Munich, from the 17th to the 23d of September. The Congress will be divided into no less than thirty-seven sections, of which seventeen are in the natural sciences and twenty in medicine. There will be two general sessions of the whole Congress, at each of which three lectures will be given. These will be 'The Results of My Expedition to the North Polar Regions,' Dr. Fritjof Nansen; 'Radiography in the Treatment of Surgical Diseases,' Professor von Bergmann; 'The Change in the Astronomical View

of the World during a Century,' Professor Foster; 'Science and Medicine,' Professor Birch-Hirschfeld; 'The Recent Development of the Methods of Theoretical Physics,' Professor Boltzmann; 'Justus von Liebig and Medicine,' Professor Klemperer. There will also be a special session of the scientific sections, at which Dr. Chun will describe the exhibition of the results of the German deep-sea expedition, and Professors Bauschinger, Mehmke and Schülke will discuss 'The Decimal Sub-division of Time and Angles.'

THE program of the seventh annual meeting for the Society for the Promotion of Engineering Education, which meets at Columbus on August 17th, 18th and 19th, gives the titles of seventeen papers that will be presented. The Council meets at 9 o'clock on the morning of Thursday, 17th; and at 10 o'clock, after a business meeting, the President, Dr. T. C. Mendenhall, will give the annual address.

THE American Microscopical Society will hold its annual meeting at Columbus in the week preceding the meeting of the Association, namely, on August 17th, 18th and 19th. The Executive Committee will meet on the 17th, Thursday, at 10 o'clock in the morning, at the Park Hotel, which is to be the headquarters of the Society. The general sessions will be held at the University, the address of the President being given on Thursday evening. On Friday afternoon there will be a conference on the use of the microscope and the teaching of botany, zoology, physiology and bacteriology.

THE party of men of science who have been in Alaska as the guests of Mr. Harriman arrived at Portland, Ore., on August 2d. Those from the East have reached home by a special train on the Oregon Railway & Navigation Company.

MR. H. BLODGETT, B.S., has been appointed assistant botanist and entomologist in the New York Branch Agricultural Station at Jamaica, L. I.

CAPTAIN CAMPBELL M. HEPWORTH has been appointed marine superintendent in the British Meteorological Office, in succession to the late Mr. Baillie.

IN the death of Mrs. Arvilla J. Ellis, of Newfield, New Jersey, on July 18, 1889, there passed away another of those patient workers to whose fidelity science owes so much. Not known as a botanist, not a member of a scientific society, not the author of a scientific paper, she nevertheless contributed more to the advancement of our knowledge of the fungi than many of those whose names are frequently appended to scientific articles in the journals. Many years ago she began aiding her husband, Mr. J. B. Ellis, in the arduous labor of preparing and mounting the specimens for the 'North American Fungi,' and later for the 'Fungi Columbiani,' and with her own hands bound the books in which these were delivered to subscribers. Had it not been for her help the first of these great distributions—numbering 3,600 specimens—would have been suspended early in its history, and the second—numbering 1,400 specimens—would never have come into existence. To her deft fingers, which wrought so patiently, botanical science is indebted for the more than two hundred thousand specimens of the fungi which Mr. Ellis distributed to the botanists of the world.

THE death is announced, at the age of seventy-five years, of M. Balbiani, professor of embryology at the Collège de France; of Professor Pasquale Freda, Director of the Station for Agricultural Chemistry at Rome; of Dr. S. T. Jakčič, professor of botany and director of the botanical gardens, Belgrade, and of Dr. Carl Kuschel, formerly professor of physics at the Polytechnic Institute at Dresden.

MR. F. W. HODGE, with the assistance of Mr. A. C. Vroman, is engaged in photographing the Prince collection of Amerind idols in Santa Fé for the Bureau of American Ethnology. This collection, made by Governor L. Bradford Prince through several years of effort, has attracted much attention from archæologists, partly by reason of the unique and puzzling character of the effigies.

WE learn from the *American Geologist* that Mr. E. S. Riggs, of the Field Columbian Museum, assisted by Mr. H. W. Menke, is in Wyoming, collecting fossil reptiles for the institution.

MR. J. B. MARCOU and Dr. Philippe Marcou, the heirs of the late Jules Marcou,

presented sometime since to the American Museum of Natural History his geological library, numbering about 3,000 volumes, 10,000 pamphlets and 1,200 maps. This is one of the largest libraries of its kind in the world, and gives the Museum the most complete collection of books on paleontology and geology in America.

Dr. Jules Maringer, who died on May 13th, left the sum of 100,000 fr. to the Pasteur Institute, Paris.

There are several vacancies in the Coast and Geodetic Survey which are to be filled by Civil Service examinations. The most important of these is the position of Inspector of Standards, for which the examination will be held on October 28th. It will consist of training, especially original investigation and published papers in physics and an essay on the functions of a National Office of Weights and Measures. On September 5th and 6th an examination for two minor positions will be held in the same Survey, that of Computor at a salary of $1,000, and of Aid at a salary of $720.

Some time ago, as we learn from the *British Medical Journal*, a sum of £2,000 was handed to General Donny by a donor who wishes to remain anonymous, to be applied in furtherance of the study of 'colonial pathology.' A committee of the Société d'Etudes Coloniales, Brussels, appointed to consider the best manner of utilizing the gift, decided to employ the money in equipping a scientific mission to proceed to the Congo State and study the diseases of hot countries in that region. Dr. Van Campenhout, an army medical officer who had already been twice on duty in the Congo, and Dr. Reding were selected for the service. After long preparation they embarked on June 29th. The Congo State has established at Leopoldsville a physiological and bacteriological laboratory, in which the work will be carried out. The same committee has offered two prizes, each of the value of £100, to be awarded (1) to anyone who shall considerably advance any knowledge of Laveran's hæmatozoon within and without the human body, and (2) to anyone who shall determine the real origin of hæmoglobinuric bilious fever.

UNIVERSITY AND EDUCATIONAL NEWS.

Arrangements have been finally made by which the London University, which, it will be remembered, is only an examining body, will be removed from Burlington Gardens to the Imperial Institute. In return for rooms in the Institute the government will pay the existing mortgage on the building of £40,000 and discharge a floating debt of the Institute not to exceed £15,000. The necessary structural alterations will be undertaken at once.

The Russian Minister of Public Instruction has issued a proclamation, by order of the Tsar, to the effect that all students who took part in the disorders last year are pardoned, excepting those who are entirely excluded from attending the high schools. Part of the students will return this month and part in August, 1900.

It is expected that a technical school will be established at Toronto, the government having offered an annual grant of $3,000 for maintenance, provided that the city erect a building at a cost of at least $100,000.

Francis Ramaley, Ph.D., University of Minnesota, has been appointed professor of biology in the University of Colorado, at Boulder, in succession to Professor John Gardiner, who has retired on account of continued ill health, having held the chair since 1889.

Professor C. S. Prosser, of Union College, Schenectady, New York, has been elected associate professor of historical geology at Ohio State University, Columbus.

Mr. W. Somerville, professor of agriculture and forestry at the College of Science, Newcastle-on-Tyne, has been elected to the newly-established chair of agriculture at Cambridge University.

Professor C. W. Röntgen, of Würzburg, has recived a call to the University of Munich.

Professor R. Abegg has been elected Associate Director of the Chemical Institute at Breslau.

Dr. Ernst Ebermeyer, professor of forestry at the University of Munich, has retired.

Yours very ty
D. G. Brinton

SCIENCE

FRIDAY, AUGUST 18, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DANIEL G. BRINTON.

IN the death of Dr. Brinton American science has suffered a grievous loss. Notably brilliant and versatile, endowed with exceptional acumen, and an indefatigable worker, he investigated much of the broad field of anthropology with signal success; a fluent and forceful speaker and a clear and cogent writer, he was remarkably successful in putting the results of his work before general auditors and readers as well as students; exceptionally public-spirited and appreciative of the normal human demand for better knowledge, he strove constantly to extend and improve instrumentalities for the diffusion of science. Thus through rich natural endowment, coupled with wise and persistent effort, he materially advanced the Science of Man and placed himself in the front rank of the anthropologists of the world. His activity continued undiminished (despite the weight of well-guarded suffering consequent on military service) until checked by the illness which terminated with his life.

Born in Chester county, Pennsylvania, May 13, 1837, Daniel Garrison Brinton graduated from Yale (A.B.) in 1858, and from Jefferson Medical College (M.D.) in 1861, and assimilated his thorough training during a year in Europe, with special studies in Paris and Heidelberg. Stimulated by the martial spirit of the time, he then returned and entered the Federal army as

acting assistant surgeon. His energy and trained skill were quickly felt in the medical department of the army, and he was rapidly promoted; commissioned as surgeon within six months after enlistment, he was soon after made surgeon-in-chief of his division, and was appointed medical director of his corps fifteen months after entering the service. During this period he participated in several notable engagements. In consequence of the severe strain attending the battle of Gettysburg, he suffered a sunstroke, which compelled his retirement from field duty, and from which, in his own judgment, he never completely recovered. He resumed service, however, as superintendent of army hospitals at Quincy and Springfield, Illinois; and, on the close of the war in 1865, he was brevetted lieutenant-colonel and honorably discharged. Returning to Philadelphia, he became, in 1867, editor of the *Medical and Surgical Reporter*, a position retained (always in connection with other work) for twenty years; he was also editor of the *Compendium of Medical Science*, and, in 1885, edited and made important contributions to one of the volumes of the 'Iconographic Encyclopædia.' In 1882 he began editing and publishing the 'Library of American Aboriginal Literature,' one of the notable scientific enterprises of the country. In 1884 he was made professor of ethnology and archæology in the Academy of Natural Sciences in Philadelphia, and in 1886 professor of American linguistics and archæology in the University of Pennsylvania. For some years he was President of the Numismatic and Antiquarian Society of Philadelphia; and in 1886 he was Vice-President and in 1894 President of the American Association for the Advancement of Science, filling these positions with great ability and dignity.

Dr. Brinton's literary contributions to American anthropology in its various aspects have been many and important. His bent toward the science began in early manhood; spending the winter of 1856–7 in Florida, he yielded to the excellent opportunity for archæologic and ethnologic work. Some of the results of his operations were incorporated in 'The Floridian Peninsula, its Literary History, Indian Tribes, and Antiquities,' 1859. With the return to civil life and opportunity for original study in 1865 the early impressions were revived and led to researches concerning the symbolism represented in the prehistoric relics and surviving among the aboriginal tribes, and the fruits of these researches saw the light in 'The Myths of the New World, a Treatise on the Symbolism and Mythology of the Red Race of America,' published in 1868, and in revised edition in 1876. Various minor publications followed, marking the progress of studies constantly increasing in breadth and depth, notably the 'Essays of an Americanist,' 1870, and 'American Hero Myths, a Study of the Native Religions of the Western Continent,' 1882; and in 1876 the impulse awakened by the Floridian symbolism found further expression in 'The Religious Sentiment, a Contribution to the Science and Philosophy of Religions.' Meantime the confinement and restriction of field work imposed by editorial duty, combined with growing mental activity, led him to seek original sources of information in the languages and recorded traditions of the native tribes. Various contributions to aboriginal philology resulted, and the impulse in this direction found full expression in the six volumes of 'Brinton's Library of Aboriginal American Literature,' 1882–1885. As his field extended his grasp strengthened, and comparisons of the Amerindian and other peoples were made with great acumen and comprehensiveness, as shown by his succeeding works: 'Races and Peoples,' 1890, and 'The American Race,' 1892; these being among America's most important contributions to anthro-

pology. Taught by professorial work to adopt diverse methods of exposition in order to reach wider circles, some of his results were dressed in literary or even dramatic form, like 'The Pursuit of Happiness,' 1894, and 'Maria Candelaria, An Historical Drama from American Aboriginal Life,' 1897; yet it was appropriately prophetic of the final rounding-out of his life work that a recent publication should be a review of the researches of two score years into the motives of primitive symbolism and a summary of his scientific studies, under the title 'Religions of Primitive Peoples,' 1897—his latest, and in many respects, his greatest contribution to the literature of science.

Largely by reason of his versatility, it is not easy to define Dr. Brinton's original additions to the body of increasingly definite knowledge comprehended under the term anthropology; his range was broad, and his touch vivified many lines of thought. Perhaps his richest gift to scientific method was that embodied in his unique library, designed "to put within reach of scholars authentic materials for the study of the languages and culture of the native races of America;" perhaps his richest contribution to the body of science is the second chapter of his 'Religions,' entitled 'Origin and Contents of Primitive Religions,' which has well been characterized as a work of genius; while certainly the influence of his eloquent advocacy of the doctrine of mental unity will long remain in the minds of the anthropologists of the world. Yet despite the difficulty of signalizing special features of well-rounded work, the great fact remains that Brinton's investigations and expositions have served to set forward the outposts of the Science of Man along almost the entire front.

During the last two decades workers in various branches of science have benefited much by Dr. Brinton's readiness to promote and diffuse knowledge by all means at his command; he conducted a large and varied correspondence in which he freely gave of his information to numberless seekers; he contributed voluminously to current periodical literature, both special and general; he was given to attending scientific meetings, and was particularly free in formal and informal communications and discussions; and he was a frequent and attractive lecturer. He was no less generous in editorial work; his name has added strength to the editorial corps and his pen has added interest to the pages of SCIENCE since the beginning of the present series in 1894; he was one of the original editors of the *American Anthropologist* (new series), and at various times he had editorial connection with other journals of scientific character.

Among scientific associates Dr. Brinton was noted for courtesy and urbanity even more than for the vigor and insistence whereby his convictions were enforced. Clear and trenchant in statement, clever and terse in debate, incisive and even sharp in criticism he was instinctively fair and tolerant; and no forceful thinker was ever readier to recognize the right of free opinion. These and other qualities united to form a strong personality, which served the world well in attracting auditors and pupils toward useful lines of thought.

It was among intimates that Dr. Brinton was seen at his best. Of refined social sense and of peculiar delicacy in word and manner, an easy and often brilliant conversationalist, and a pleasing raconteur, he was a delightful companion, charming host, or ideal guest, as occasion demanded. Naturally his associations warmed into friendships, many and deep; and the passing of his life has rent unnumbered ties and wrought widespread sorrow.

Surviving more than three-score years despite an infirmity of war concealed with

Spartan care, and living a remarkably busy life, it is but natural that Dr. Brinton should become a prominent figure of his times. His death creates a void that must long be felt; yet few American scientists have left worthier monuments in the form of finished works.* W J M.

PRESIDENTIAL ADDRESS BEFORE THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.†

The presidency of a Society which embraces in its membership representatives of all the leading schools of engineering and applied science in this country is an honor which one may not lihgtly accept or indifferently bear. Although not established by its organic law, its traditions make it the duty of the presiding officer to present an address which should be, in spirit, at least, worthy of so important an occasion. Happily for those upon whom this honor may fall, custom has not yet restricted or defined the sphere of discussion which shall be thought suitable for such a paper; on the contrary, one may properly take advantage of this opportunity to become temporarily a *ronin*, a free lance, attacking everything and everybody, seeking only to give full and fair exposition of one's own personal, and, may be, peculiar views. This is the one compensation going with the burden which the Society insists must accompany the honors which it bestows. No apology is needed, therefore, for the selection of a topic the consideration of which may seem more or less irrelevant and unnecessary to some and, perhaps, unwelcome to others. In the present instance the choice is due to a strong conviction that schools of engineering are, for the most part, far from doing their full duty in an important matter, namely, the inculcation and dissemination of sound views, both theoretical and practical, relating to scientific metrology.

We cannot ignore the fact that the general public, even the intelligent public, receives its information regarding scientific and technical questions almost entirely from daily newspapers and popular magazines, than which, we will all admit, there could hardly be a more untrustworthy source. The widespread taste for sensationalism by which we are now cursed, a taste which seems to grow with the efforts made to satisfy it, offers a premium upon anything startling or revolutionary, giving little heed to sober, every-day truth. If one-tenth of the wonderful scientific discoveries that have been announced with glaring headlines in the public press within the last five years had *actually been made* it would, indeed, have been an epoch-making period; but, fortunately for everybody, they existed mostly in the brilliant imagination of the space writers who alone were benefited by their publication. If this were all we could afford to be indifferent, but there is the further disagreeable fact that a large number of intelligent people are led to look upon this sort of thing as real science, and few of us have an adequate conception of the extent of this delusion. One of the results is that in science, as in many other things, those who do the real work of the world fail to be credited with it, while the people are lavish in their praise of those whom they *believe* to be worthy. Only a few weeks since I found in an article on teaching history, written by the superintendent of schools in a large city, the names of a quartet of Americans most distinguished in war and peace. Three of the four were Washington, Lincoln and Franklin. As this is not meant to be a humorous paper, I will not mention the fourth, contenting myself with saying that in this instance the newspaper had done its work well.

*The portrait published as frontispiece is from a photograph taken in April, 1898, by F. Gutekunst, Philadelphia.

† Given at the Annual Meeting, Columbus, Ohio, August 17, 1899.

A curious and, in my judgment, a seriously instructive example of the readiness with which people accept newspaper science is found in the attempt made a year or two ago to fix the value of the ratio of the circumference to the diameter of a circle by legislative enactment. This incident may be familiar to some of you, but it is entirely worthy of consideration by those to whom is entrusted a large share of the instruction in exact science in American colleges. The legislative body involved was not one of a State south of Mason and Dixon's line nor west of the Mississippi River. It was a body chosen by the people of one of the greater States of the Union—one deservedly enjoying considerable distinction, especially in literary circles, on account of the eminent men it has produced, and also for the excellence of its educational institutions. In this Legislature, House, Bill No. 246 was entitled 'A Bill for an Act introducing a New Mathematical Truth,' * * * which truth, in the second section of said bill, turns out to be that the circumference of a circle is just $3\frac{1}{5}$ times its diameter. In the capital of the State is published a daily morning paper of unusual excellence. Not generally given to sensationalism, its contents are usually clean and wholesome, its news well collected and arranged, and even a single copy gives the impression that it is an example of the better phases of journalism. Yet this paper devoted more than two columns of its first page to an exploitation of this most important discovery, which had been made by a physician living in an obscure corner of the State. It was announced that the laws of the quadrature had been copyrighted and that this newspaper was allowed to be the first to make them public, this privilege being, without doubt, the bait which caught the uninformed editor. Some measure of his credulity may be found in his sober declaration that the circle-squarer's demonstration had been accepted by all eminent mathematicians; that the *American Mathematical Journal*, the highest authority in the country, had hastened to publish it, and this publication instantly attracted the attention of the scientific journals in Paris, the editors of which had eagerly sought contributions from the author of the discovery. The solution had been copyrighted in the United States and in England, Germany, Belgium, France, Austria, Italy and Spain. At Washington it had won the support of the professors of the National Astronomical Observatory, Professor Asaph Hall, 'whose fame was secure with the discovery of the moons of Mars' being specially delighted with it and finding in it a complete explanation of a hitherto unexplainable anomaly in the earth's motion. The desk of the discoverer was full of letters from leading mathematicians in Europe and America, and one from his agent in London proved that his demonstration had been shown to Tyndall and Huxley, who warmly endorsed its accuracy. Professors in Ann Arbor and from Johns Hopkins University had seen the demonstration and declared it perfect. I leave to the guardians of the name and fame of these institutions, and to others referred to, the task of ascertaining just what lineal descendant of Ananias was at that time on the editorial staff of this journal, but the actual disposition of the bill by the legislative body is a matter of much interest. When introduced, it was taken humorously by the Speaker of the House, who happened to be a graduate of a widely known educational institution, and he ordered its reference to the Committee on Swamp Lands. Two days later, however, the great discoverer had a hearing before the State Superintendent of Public Schools and the Committee on Education, who at once endorsed the solution; the Committee on Canals and Swamp Lands

reported House Bill No. 246 back, with a recommendation that it be referred to the Committee on Education; the latter Committee gave the bill careful consideration and reported 'the same back to the House, with the recommendation that the said bill do pass;' the bill was called up by the Committee and, *mirabile dictu*, the bill actually passed that branch of the Legislature, by what was reported to be a good, safe majority. Before it actually became a law, however, its character began to be recognized and its further progress was arrested. The possibility of such an incident at the very end of the nineteenth century is a fact from which some useful inferences may be drawn, and a just allotment of responsibility might well cause some anxiety.

But it is not to the particular kind of metrological reform suggested by this incident that I desire to ask your special attention. Josephus says that Cain 'broke the tranquility of the world by introducing weights and measures,' and it is perhaps not without significance that the first exponent of precise measurement was also the first homicide. At any rate, it will not be denied that the welfare of mankind has been enormously affected by the development of the art of weighing and measuring, and the importance of this art has grown with the perfection and complication of enlightened society. The systems of metrology in general use among English-speaking people at the present time have come to us from remote, almost pre-historic time, through Greece and Rome, and thousands of years have passed without any marked improvement in them, except in the betterment of fundamental standards, the interrelation of which is still as essentially illogical and unscientific as in the beginning.

As every one knows, the nineteenth century has witnessed a marvelous metrological reform among nearly all other races, and it is of this reform, never so important to us as just now, that I propose to speak. I am glad to assume in the beginning that you are all quite familiar with the general facts relating to this controversy, and I ask your consideration of the subject, not because of any lack of knowledge on your part, but rather because of my belief, already expressed, that you and the work you stand for have failed in a large measure, perhaps for lack of interest, in the active dissemination, among the general public, of the principles and advantages of a reformation of vital consequence to their material interests.

A brief review of existing conditions will be of use to those who have not given the subject serious thought. It is not generally known that the legal, fundamental standards of length and mass in this country are as numerous as the States of the Union. It will not do to say that these are identical, for they are not and cannot be, and many of their derivatives are decidedly different. There is a widespread notion that there is a United States standard pound which is everywhere legal, and a yard of the same authoritative origin, but this is an error, for these are only legal in transactions to which the general government is a party, and then only by authority of the Secretary of the Treasury. There is but one commodity which must everywhere be measured by one standard, and that is the coinage. And even this is nominally, not actually, referred to a material standard, legalized over seventy years ago, which is obsolete in form and construction, 'without pride of ancestry or (let us be thankful) hope of posterity.' Practically we ignore all legislation in the matter of fundamentals and universally accept standards of mass and length from two or three prominent makers who have mostly adopted those of the U. S. Office of Weights and Measures. There is much local legislation, however, on derived measures and much confusion results

therefrom. As an example, an act passed by the State of Massachusetts only five years ago may be cited. It legalizes *twenty-six* different bushels in one section, while in another it declares that a bushel *in heap measure* shall contain 2150.42 cubic inches, this being the volume of the well-known Winchester bushel when flat or struck, as used by the U. S. government and almost everywhere in this country. It also legalizes a dry gallon of 282 cubic inches, together with the liquid gallon of 231 cubic inches, which the government uses, thus creating an absolutely unnecessary but extremely annoying confusion. In one State there is a law that innkeepers "shall sell beer and ale by wine measure to all persons as drink it in their houses and by beer measure to all persons as carry the same out of their houses"; in another, and this in New England, it was enacted comparatively recently that in measuring certain commodities "one bushel and three quarters of a peck shall be deemed a bushel." In spite of legislation in many States fixing the value of a barrel at 31½ gallons, it contains in these same States almost invariably 40 or 42 gallons. In one State a gallon of milk must contain 231 cubic inches; in another its capacity is fixed at 282 cubic inches. Not only is the value of a bushel when determined by weight different for different commodities, but for the same commodity there is great variation among different States of the Union, amounting, in many instances, to fifty and seventy-five per cent. I need not consume your time in relating the many other inconsistencies and absurdities inherent in our present system, such as the variety of meanings attached to the word *ton*, not less than three or four in number; the confusion of pounds, ounces, etc.; the elusive and uncertain meaning of *perch*. With all of these and many others you are already familiar, and the whole system is so fearfully and wonderfully made that it may be safely affirmed that no man lives who knows and understands all of it.

Nor is it necessary for me to consider the origin and nature of the system which those interested in metrological reform wish to see installed in its place. Most, if not all, of you know it very well and have been accustomed to make use of it in a greater or less degree. The innumerable advantages of a system of metrology as simple and as scientific as that known as the metric system are now all but universally admitted. They have been written about and talked about and learned by actual use to such an extent that a presentation of them here would be a waste of time. I prefer to briefly consider a few of the more important arguments that have been made against this system or against its use in this country. There is a certain class of objectors, small in number, quite unworthy of serious consideration. Among them are those who see something sacred in the yard and the pound, because they are relics of antiquity, and something inherently wicked in the metre and the kilogramme because they originated with the French during the Revolution at the close of the last century. To some of them the very mention of the metric system is like a red flag to an anarchist, and two or three of them have published elaborate but tiresome arguments against the proposed reform, abounding in inaccurate statements and illogical and unscientific propositions. They mostly reveal a condition of intellectual atrophy over which it is but common charity to draw the veil of silence. There are, however, some criticisms of the metric system that are entitled to the most serious consideration on the part of its friends, and some of them are urged by those who would gladly welcome metrological reform if it came in a way which met their approval. The advocates of the metric system not only do not wish to

avoid rational criticism, but they heartily desire it, believing that the more widely it is known and discussed, the more its advantages are understood, the more enthusiastic supportors it will have.

One of the commonest arguments against it, one well known to all of you, I am sure, is that it is decimal and not duo-decimal or binary, or based upon some devisor other than ten. One may admit, for the sake of argument, that there would be advantage in subdividing a unit by continual bisections, but the extremely limited area to which this advantage would be restricted is almost universally overlooked. It is forgotten that it is only when measurements are the result of estimation or judgment that this superiority would be felt. This being admitted, it further follows that the exercise of judgment, wherein bisection may possess an advantage, occurs only when a single undivided unit is under consideration, and who will claim for a single instant that the difficulty of estimating a fraction of a unit is in the least dependent on whether that unit is itself the tenth or the eighth or the twelfth of another. The plain fact is that if one is contemplating the metre as a unit it is just as easy to think of or set off a half, quarter or eighth or sixteenth part as if it were a yard, and the same is true of the decimetre or centimetre when compared with the foot or inch. Indeed, one who is accustomed to use the metric system speaks and thinks of a half or quarter centimetre or a half or quarter millimetre without the slightest embarrassment, never imagining that he is in the least inconsistent or 'disloyal' to the decimal system. It is curious that this objection should be urged by people who have long ago become accustomed to a like condition of things in their currency and who would be extremely unwilling to go back to a system non-decimal in character. No one will pretend that the sub-division of a dollar offers any inconvenience and every one knows that the superiority of the decimal system in currency is so manifest that nearly all nations have adopted it in one form or another. Whatever disadvantages might be anticipated in the use of the dollar or the metre with decimal sub-divisions are involuntarily destroyed by the natural tendency to refer to smaller units rather than to continuous bisections. Thus we may talk of a half metre, or a quarter metre, but for smaller quantities the decimetre or the centimetre are at once chosen, and when we wish to go below a half of a cetimetre the millimetre offers itself as a convenient unit. In the same way we find no embarrassment in taking up the cent as a unit when it is desired to go below a quarter of a dollar. That the several units thus used are decimally related to each other is the one fact that makes all of this beautiful simplicity possible. I have ventured to elaborate somewhat on this point because many people are of the opinion that the fact that the radix is ten and not two is a really serious objection to the metric system. It is believed, however, that careful study of the principles involved, following the lines indicated above, will show that this fact is of no importance. And it must not be forgotten that our present system is anything but binary and that the adoption of almost any radix would be an enormous improvement. But, above all of this, it must be remembered that nobody claims any special virtue or unique qualities for the number *ten*. It is not because it is decimal that the metric system is so far superior to all others. The superiority rests upon two great facts, the first of which is that the radix of the system is identical with that of the system of notation and numeration now and for many years in use by all civilized people. It may well be that a binary or duodecimal or some other system of notation would offer advantages over that which has prob-

ably fixed itself upon us for an indefinite future, but it is absurd to argue that metrological form must wait upon a notational revolution. The probability of the latter is almost infinitely small, at least for centuries to come, while already a majority of civilized nations have adopted the decimal system of weights and measures. The other great fact on which the superiority of that system depends is the beautifully simple inter-relation of units, resting upon constant physical properties of matter. No other system is for a moment comparable with it in this respect, and this alone would entitle it to consideration and adoption by all progressive communities. I pass over many more or less trivial objections to the metric system, all of which have been successfully answered many times, to take up one which is of far greater importance than all others, although it is not really a fault in the system itself. It is urged that the adoption of the system in this country must be accompanied by very large loss, especially among machinists and manufacturers, of accumulated material in the form of tools, machines, patterns, etc., which have been designed and made upon a basis of the foot or inch unit of length and which would be rendered useless by the introduction of the metre or centimetre. It is also argued that there would be great loss occasioned by the disuse of scales, balances, weights, etc., which would necessarily be replaced by metric measures. On these grounds several very able engineers have based a strenuous opposition to the proposed reform, and their influence is freely admitted to be the most serious obstacle to its progress.

Against this argument a few incontrovertable facts are put. One of these is that only a relatively small proportion of tools and machines are in any way effected by the question of standards; another is that the life of a tool or machine in these days is comparatively short, not only on account of deterioration from use, but as well because of continual improvements which render designs only a few years old practically worthless. Much has been said about the enormous value of patterns for machinery and machine tools which have accumulated during a period of years and which would be rendered useless by the introduction of new standards. Concerning this it may be said that in many of the most extensive manufacturing establishments in this country patterns once used are not considered as assets at all, the chances being that, through the rapid improvement in design constantly going on, they will shortly become obsolete. There is also the further fact, testified to by some important establishments in which the metric system has already replaced the old, that there is almost invariably enough to spare in a casting which is to be machine finished to make it possible to work it to metric dimensions. In a similar way the possible cost of the reform due to the necessary change in apparatus and standards for weighing and measuring has been grossly overestimated. Balances will be, of course, not affected at all; platform and other scales can readily and cheaply be adapted to the new units. Those who have maintained a somewhat bitter opposition, based on this question of cost, to all suggested legislation looking to metrological reform, seem to have ignored two important considerations; the first is that the thing which they proclaim to be so difficult that it is practically impossible has already been accomplished and many times, by different European nations with almost no difficulty and under conditions vastly less favorable than those existing with us. The second is that no reasonable advocate of the metric system expects the transformation to be made in a night or in a month or a year. The history of the adoption of

our currency system furnishes a useful example of what may be expected. More than a generation elapsed after it became the legal system of the nation before its use was even approximately universal.

There is another objection to the metric system important enough to deserve examination, and that is the alleged difficulty of understanding it and of becoming accustomed to its use, and it has been affirmed that this difficulty would be especially marked among mechanics and workmen of all classes who make frequent use of weights and measures. Here, again, we may best appeal to experience. To Germany, Austria, Italy, Spain and other European nations outside of France the metric system came as a foreign innovation, but nowhere was any serious difficulty experienced. The same may be said of practically every nation on the American continent, excepting the United States and Canada. Before a Parliamentary Committee, Siemens testified concerning its introduction in his own works in Germany, that "it was all a matter of about a fortnight or three weeks; then the people were accustomed to it and did not ask for any more of the old measures, but asked for the new." In Germany the Adopting Act was passed in 1868, and the use of metric measures was made compulsory in 1872. Siemens testified that this actual adoption took place mostly between January 12, 1870, and January 1, 1872, and that when the compulsory time came there was nobody to be compelled. Other German testimony was of the same character, that knowing they had to be ready when the time came they were ready before the time came. Professor Foerster, Chief of the German Bureau of Weights and Measures, under whose direction the introduction of the metric system was made, has furnished us a most interesting account of how it took place. In speaking of the complaint, then common in Germany, as it has been here, that the metre was too long, that "we can estimate by the foot and not by the metre," he makes the very suggestive remark that "experience has shown that here too many people have only hung a cloak around habit in order to hide its nakedness." You are doubtless all aware that a few years ago in the great English engineering establishment of Willans & Robinson the metric system was adopted to the entire exclusion of British measure. Their testimony is strongly in its favor and shows that English workmen very quickly adapt themselves to its use, and when once they understood it all agreed that it was much easier to work to than the English system. The head of their tool room testified that "it was a little awkward for a time," but this lasted only about two days. Some of our own large manufacturing establishments having branches in Europe, such as the General Electric Company, have declared that they found a decided advantage in making and working to metric drawings. Indeed, there is an 'embarassment of riches' in testimony of this kind, and I feel that I ought rather to apologize for bringing any of it before this body. We may justly regard the case as proven and the controversy closed, except as to the question of ways and means. If it be affirmed that there is no demand for the change I could deluge the Society with resolutions of chambers of commerce, boards of trade, manufacturers' associations, engineers' clubs and societies, builders' exchanges, architects' clubs, pharmaceutical associations, trades unions, educational and scientific bodies and other public organizations too numerous to even name. In England the past five years have witnessed what is little short of a revolution of sentiment on this question, the result of an agitation originating not among scientific men, but with the so-called practical people. It is there, as it must soon be here, a question

of vital importance to commerce and trade. The testimony of their far-sighted consular agents in various parts of the world is that British trade with all nations except our own is sadly handicapped by its units of measure, and our own consular reports are of the same tenor. Within a year we have entered upon a new era in our foreign relations. Our trade with foreign nations has increased enormously and must increase still further if we are to maintain our footing. We have already absorbed a considerable population by whom the metric system has long been used, and our merchants and manufacturers are already feeling the disadvantages of our antique and irrational measures of quantity. Fortunately for us, our principal competitors are the English, who are carrying nearly the same burden. But they have been quick to recognize the necessity for reform and in five years they have made more progress towards it than we have in thirty.

Schools of engineering and professors of engineering and applied science can do more, if they are so minded, to help their country in this emergency than any other agency that I know of. They can do it by a more liberal use of the metric system in their daily work. Electrical engineering, by a wonderful stroke of good fortune, emancipated itself from this curious slavery in the very beginning, and its astonishingly rapid growth from infancy to the vigorous manhood which it now enjoys is very largely due to that fact. In the engineering college of to-day the student in physics and chemistry is brought into close relations with the metric system, but when he advances to his professional studies in civil and mechanical engineering he is too often compelled to relapse into the exclusive use of the foot, the pound and the gallon. I am far from recommending the abandonment, at this time, of these useful units, but I strongly urge the importance of allowing them to share their work with their metric analogues and very liberally. Even if there were no other advantage there would be an enormous gain to the student in compelling him to do his problems and his laboratory exercises in more than one system of units, than which nothing contributes more to clearness of understanding and soundness of knowledge. If we had begun this a quarter of a century ago and kept it up we should be in much less danger of being beaten in the race for the markets of the world than we are to-day; for this system is bound to become universal and in the near future. The prodigious advantages which it offers in its simplicity, its economy and its already extensive use will insure this. No body of men can more effectively influence public sentiment to an appreciation of this fact than those I now address.

One of the ablest and most scholarly arguments in favor of the metric system ever made was that of Charles Sumner in the Senate of the United States more than thirty years ago. He summarized the argument as follows: "A system of weights and measures born of philosophy rather than chance is what we now seek. To this end old systems must be abandoned. A chance system cannot be universal. Science is universal; therefore, what is produced by science may find a home everywhere."

T. C. Mendenhall.

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*WORK OF THE U. S. GEOLOGICAL SURVEY.**

Appropriations for the work of the U. S. Geological Survey for the current fiscal year amount to $806,000 as against $816,000 for the preceding fiscal year. The apparent decrease is largely because of special items appropriated in the former year, one of which, for printing and binding monographs, amounted to $40,000. The amounts for

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actual field work and office compilation thereof are, in fact, increased. In the two items of topographic surveys in general and topographic surveys of forest reserves there is an increase of $40,000 over 1898–99, and $10,000 was added to the amount for collecting and publishing statistics of mineral resources. A special appropriation for surveys in Alaska carries $25,000, a sum the same as was available last year.

Topographic Branch.—The increase in the appropriations for topographic surveys resulted from the demands of Eastern States that cooperative surveys should proceed more rapidly. Cooperative surveys are now in progress with New York, Pennsylvania, Maryland, Maine and Alabama. The total sum of appropriations by these States for cooperation amounts to $48,500. The Geological Survey is pledged to expend in each of these States an amount equal to that appropriated by it, and a State Commission or its representative determines the order of procedure of surveys; the work in New York, for example, is directed chiefly to surveys of the areas of water supply for the Erie Canal and the Hudson River, whereas in Pennsylvania stress is laid upon the importance of topographic maps to serve as bases for detailed geologic surveys of the coal, oil and gas regions. In Maryland the topographic work is distributed according to needs of the State Geological Survey, and the larger portion of the State has been surveyed. Cooperative surveys have not been entered into by any of the Western States. The federal appropriations are little more than sufficient to survey one quadrangle (approximately 1,000 square miles) in each State and to extend the necessary triangulation and spirit-level control. The purposes which determine the selection of areas of topographic surveys are to a large extent economic, and are related to the development of mining districts, water resources and forest reserves. The first of these purposes includes also the surveys for general geology, which are usually extended over districts where economic interests are important. These topographic operations throughout the United States as planned for the present year are estimated to cover about sixty-five quadrangles on two different scales, or a total area of about 45,000 square miles.

The character of the topographic work is constantly improving, and the evolution of the topographer from the grade of a surveyor to that of a scientific observer is progressing. Whereas formerly the strongest man in any party was engaged in the more precise instrumental work, such as triangulation and leveling, and sketching topographic features was the work of subordinates, the reverse is now the case. The topographer in charge of the party is responsible for the expression of the map, which can only be satisfactory when controlled by experience and executed with artistic skill. Furthermore, the topographers are required to observe and note on the maps the classification of lands, as cleared or forested, and many of them take a scientific interest in the physiographic development of topographic forms. The tendency at the present time is to increase their responsibility and to make the place worthy of men ambitious to broaden knowledge of the conditions which fit the earth for man's habitation.

Geologic Branch.—In the northeastern district of the Appalachian province, comprising New England, eastern New York, and New Jersey, a number of competent geologists are engaged in the study of the difficult problems presented by the metamorphic sedimentary and igneous rocks. In the Adirondack area surveys of the southeastern portion of the mountains adjacent to Lake Champlain have been extended to cover nearly 1,000 square miles, lying between Lake Champlain and the

heart of the mountains. The greater part of the area is in the pre-Cambrian igneous rocks, and the problems relate to the sequence of eruptives and the character of metamorphism suffered by the anorthosites. The researches indicate an eruptive origin for the great magnetic ore bodies as parts of gabbro masses. A paper has been contributed to the 19th Annual on this subject (The Titaniferous Iron Ores of the Adirondacks, J. F. Kemp, 19th Annual Report). Preliminary surveys were begun last year in the region southwest of the Adirondacks in the Old Forge quadrangle, where the relations of igneous rocks to certain limestones are the more interesting questions.

The work begun by Pumpelly in the Green Mountains in Massachusetts, comprising the Housac and Greylock ranges, has been extended in several directions by those who were associated with him. In eastern New York, where Walcott had worked out the general outline of the problems, the complex stratigraphy and structure of the Paleozoic rocks have been unraveled practically from Manhattan Island to the vicinity of Rutland, and the relations of Cambrian and Silurian strata to Archean and Algonkian nuclei in northeastern Massachusetts and southern Vermont have been further investigated. Nearly all of Massachusetts as far east as the edge of the Boston basin has been surveyed according to the classification of the rocks published by Professor Emerson in the Holyoke folio and in the Monograph on old Hampshire county, and this work is progressing from the Massachusetts line southward in Connecticut. The difficulties of determining the origin and relationships of the unfossiliferous gneisses and schists which make up this area are so great that progress will probably be slow and differences of opinion may arise. It is accordingly advantageous that representatives of the several great universities are engaged upon the work.

In the eastern part of New England special studies have been made of the post-Cretaceous formations of the Elizabeth Islands and of Nantucket and Cape Cod; and an elaborate investigation of the Narragansett coal field has been completed, the results being published in Monograph XXXIII., entitled 'Geology of the Narragansett Basin,' by N. S. Shaler, J. B. Woodworth and August F. Foerste. In northern New Jersey surveys have been made of the Franklin Furnace quadrangle, including the celebrated zinc mines. A topographic map on a specially large scale was made, and through the courtesy of the companies the mine maps are available. These results will all be published in the Franklin Furnace folio of the Geologic Atlas.

For several years the geology of Manhattan Island and vicinity has been studied in its various aspects. The topographic surveys have been brought up to date, and it is proposed to issue a New York special folio, comprising about fourteen maps, to exhibit the surficial geology, under geology, structure and economic resources of the Patterson, Harlem, Staten Island and Brooklyn quadrangles. The field work for this folio is completed.

In the vicinity of Philadelphia the crystalline schists and gneisses present relations not unlike those of similar rocks in New England. Their distribution and relations have been worked up, and the results are to be elaborated in the Philadelphia folio of the Geologic Atlas, comprising the Germantown, Norristown, Chester and Philadelphia sheets. Through cooperation with the Maryland Geological Survey and through the work which has been in progress in Virginia, North Carolina and Georgia for ten years or more, a fairly complete reconnaissance of the crystalline schists has been accomplished throughout the Appalachian province, and their detailed relations have been unraveled in the

vicinity of Baltimore, Washington, and to some extent in the Smoky Mountains of North Carolina. The coordination of the observations in the pre-Cambrian rocks is entrusted to Professor Van Hise. The results will be published in part in cooperation with the Maryland Survey, in future folios of the Geologic Atlas, in the Washington folio, for which the manuscript is in hand, and in reports and folios relating to the Cranberry and Cherokee districts of North Carolina. This last-named work is performed partly in cooperation with the State Geological Survey of North Carolina.

In the Atlantic Coastal Plain the latest contributions to geology have resulted from the investigations supported by the State Surveys of New Jersey and Maryland. The study of the surficial deposits broadened the basis of stratigraphic discrimination, and the combination of minute observations in stratigraphy with elaborate studies of paleontology has led to recognition of important details in the Eocene and Miocene sections. Our views of unconformity and of the nature of oscillation of the Coastal Plain will probably be widened by the publication of these results. That, however, is not yet an immediate prospect, except in so far as they have appeared in the State reports of New Jersey and Maryland.

Surveys of the unaltered Paleozoic strata in the folded zone of the Appalachian province are not now being extended. The number of quadrangles surveyed and folios issued or about to be issued is large. With the exception of one folio, the Maynardville, shortly to appear, the valley and a part of the plateau region of eastern Tennessee are mapped in published folios, and the area of continuous surveys extends into Georgia and Alabama on the south and into Virginia on the north. Representative folios for the valley of northern Virginia cover over 6,000 square miles and fully exhibit the peculiarities of structure. Folios relating to Paleozoic stratigraphy and Appalachian structure issued during and since 1896 are Nos. 27, 28, 32, 33 and 35, or the Morristown, Tenn.; Piedmont, Va., Md. and W. Va.; Franklin, Va. and W. Va.; Briceville, Tenn., and Gadsden, Ala., respectively.

The accuracy of the work performed by geologists who preceded the United States Survey in the Appalachian coal fields, and the importance of the economic interests involved, led to the use of the most careful stratigraphic and structural methods in that field. Unwilling to trust to correlation of lithologically similar strata which have not been mapped continuously, the geologists have measured and named local sections on the assumption that they may not be able to correlate the individual beds in each. The position of any stratum is determined throughout a network of intersecting sections which are checked against the bench marks established by precise level lines in course of the topographic survey. Lithologic variations are carefully noted from area to area, and each distinctive lithologic unit is identified so far as it is actually traceable, but correlation is not continued beyond that point. The stratigraphers have been greatly aided by the appreciative cooperation of the paleobotanist, and the result will be to establish our knowledge of the stratigraphy of the Coal Measure formations upon a sound basis of fact. The tendency of the observations is to replace the conception of uniform and widely extended strata by the recognition of numerous irregular and overlapping lenses, and to demonstrate that the later Carboniferous formations exhibit the character of coastal plain deposits rather than that of marine strata. The folios more recently published with reference to the Appalachian coal field are Nos. 34, 40, 44, 46 and 47, or the Buckhannon, W. Va.; Wartburg, Tenn.; Tazewell, Va. and W. Va.; Richmond, Ky.,

and London, Ky., respectively. The last two, the Richmond and London, include the western margin of the field. The eastern margin is described in several of the folios published, and others are in course of preparation.

Studies in Pleistocene geology have been pursued by Professor Chamberlin and his assistants during more than a decade. Through a conservatism which justifies confidence, even though the impatient may at times have thought it excessive, the publication of results has been postponed until the criteria for discriminating the several episodes of glacial occupation and the various genetic types of glacial formations have been fully elaborated. The final preparation of manuscript was, however, begun nearly two years ago, and the first of a series of monographs upon the Pleistocene history (Monograph XXXVIII., The Illinois Glacial Lobe, by Frank Leverett) is issued. In this connection also may be mentioned Monograph XXXIV., The Glacial Gravels of Maine and their associated Deposits, by Geo. H. Stone.

The extraordinarily difficult investigation of the relations of iron-ore deposits in the Lake Superior region, which was begun by Irving and has been continued under Van Hise, is approaching a successful completion. All of the great iron-producing districts except two have been carefully surveyed, and the field work on these, the Vermilion and Mesabe districts of northern Minnesota, is far advanced. The series of monographs which set forth the observations and conclusions are a monument to the scientific spirit and executive ability of their authors. It is probably not too much to claim for them a foremost place in the rank of great geologic works. Very rarely has a problem of equal magnitude and difficulty been so elaborately studied and adequately solved. The principles of investigation developed in the course of this work are a contribution to geologic methods and will facilitate further researches of a similar character. To name only the latest of the resulting publications, reference may be made to Monographs XXVIII. and XXXVI., the former entitled 'The Marquette Iron-bearing District of Michigan,' by C. R. Van Hise and W. S. Bayley, and the latter, 'The Crystal Falls Iron-bearing District of Michigan,' by J. M. Clements and H. L. Smythe, published also in condensed form in the 19th Annual.

Studies of the stratigraphy of the Great Plains, more especially of the content of artesian waters, form an important item in the list of activities of the Survey. In the Pueblo folio the standard was set for precise discrimination of the formations and adequate illustration of their distribution and structure. The Geologic Branch, cooperating with the Hydrographic Branch, has extended more general investigations over parts of Nebraska and South Dakota. At present the surveys are being executed for the eastern and south margin of the Black Hills and the adjacent plains. The latest contribution to the subject is a preliminary report on the geology and water resources of Nebraska by N. H. Darton in the 19th Annual Report. The 18th Annual also contained an article on 'New Developments in Well Boring and Irrigation in Southeastern South Dakota.' Observations of the temperatures of artesian waters have led to the discovery of interesting variations in underground temperatures which are being made the subject of careful investigation.

In the southern portion of the Great Plains province work is progressing in Indian Territory. The coal fields of Indian Territory are structurally related to a series of folded and faulted sandstones and limestones along their southern margin, as the Cumberland plateau is related to the formations of the Appalachian Valley. The coals

lie in basins of moderate depth, and the strata along their southern limb are sharply folded and overthrust. The progress of the work is such that the McAlester folio will probably appear during this fiscal year. Among the observations of scientific interest is the determination of strata of probable Silurian age in sandstones previously considered to be Carboniferous. In the 19th Annual there is an article entitled 'The Geology of the McAlester-Lehigh Coal Field,' by J. A. Taff.

The geology of Texas is associated with the name of Robert T. Hill. Under his direction a large map has been prepared of the State on the scale of 25 miles to the inch, including portions of Oklahoma, and an account of the physical geography has been written to accompany it. This will appear as a folio of the Topographic Atlas of the United States, coordinate with the folio on physiographic types. 'The Geology of Black and Grand Prairies, Texas,' a comprehensive discussion of the stratigraphy and structure of the Cretaceous and later formations, is completed and offered for publication, and an article on 'The Geology of Portions of the Edwards Plateau and Rio Grande Plain Adjacent to San Antonio, Texas,' by R. T. Hill and T. W. Vaughan, appeared in the 18th Annual.

The Rocky Mountains occupy the attention of several parties. There the problems of stratigraphy, structure, metamorphism and vulcanism make it scarcely possible for any one geologist to do justice to the phenomena of a single area, particularly in the present development of special branches of geologic research. In the San Juan Mountains of Colorado surveys have for several years been conducted with a degree of care and detail which must result in a mass of well established fact and afford the foundation for valuable generalizations. In age the formations range from supposed Archean to post-Tertiary; in character they include an immense variety of sedimentary and igneous types, and in structural relations bearing upon the problems of vulcanism and orogeny they are of the deepest interest. The exposures in the rugged but rarely inaccessible heights are very clear, and the work is being done on a scale which affords opportunity for the elaboration of detail. The district offers a definite though complex problem, and it is being worked out according to a systematic plan. The 18th Annual contains a preliminary report on the mining industries of the Telluride quadrangle by C. W. Purington, and the Telluride folio by Whitman Cross will shortly be issued.

Among the publications which serve to add materially to the available information concerning the geology of Colorado are the Elmoro, Walsenburg and Spanish Peaks folios, the manuscripts for which have recently been received by the Survey in accordance with a contract entered into a number of years ago. The area which they cover comprises a portion of the plains and the foothills of the Rockies and extends to the Spanish Peaks, where the phenomena of successive intrusions of various types of igneous rocks are exceedingly interesting. The relations of the eruptives have been elaborately worked out and appear to indicate a genetic sequence of petrographic types.

Although work in the precious metal districts is not confined to the Rocky Mountains, that which has been conducted under the general direction of Mr. Emmons may most connectedly be introduced here. This work is on a much larger scale than that of the geologic investigations as a rule, and is directed to the solution of problems of development of fissures and distribution and occurrence of ores. It involves usually the detailed study of an area specially surveyed on a large scale, and also the minute investigation of all accessible underground

workings. The examination of the Butte district was undertaken in 1896, and the Butte Special folio has been published. The Tintic district in Utah was surveyed in the following season, and the results appear in the 19th Annual Report under the title of 'The Geology and Mining Industry of the Tintic District, Utah,' by Geo. W. Tower, Jr., and Geo. Otis Smith.

The Deadwood district in the Black Hills of South Dakota next claimed attention, and areal and economic surveys are now in progress there. Apart from the economic interest, the region presents geologic features of comprehensive and significant character. The literature of the subject of laccoliths will receive an important addition when a report on the structural relations of the rocks in the Spearfish and Sturgis quadrangles is published. It is anticipated that this season will suffice to finish the necessary field work.

In Montana the work begun by Mr. Hague in the Yellowstone Park has, during a number of years, been extended northward nearly to the boundary of British Columbia, and surveys on the scale of 2 miles to the inch have replaced those on the formerly adopted scale of 4 miles to the inch. The Fort Benton and Little Belt Mountain quadrangles, covering together nearly 7,000 square miles, have been surveyed in connection with studies of the Neihart mining district. They will be published as folios of the Geologic Atlas. More detailed accounts of the geologic observations in Montana appear in the 19th Annual Report, Geology and Mineral Resources of the Judith Mountains of Montana, by W. H. Weed and L. V. Pirsson, and are contained in an elaborate article in the 20th Annual, 'The Geology and Mining Districts of the Little Belt Mountains,' by the same authors. This last is almost a monographic work, both in size and detail. Detailed areal surveys have been carried out in the Boulder and Helena Special quadrangles, and topographic surveys in preparation for geologic work have been conducted in the Bitter Root Valley. The discovery by Mr. Walcott of pre-Cambrian fossils in the Belt terrane of Montana lends additional interest to the northwestern extension of the Rocky Mountains, of which these rocks form a large part.

Mr. Hague's monographic work upon the Yellowstone National Park has been energetically pushed, and the volumes are well advanced. The surveys of the Absaroka Range to the east of the Yellowstone Park are represented in the Absaroka folio, which will shortly be issued from the press. The remarkable phenomena presented by volcanic breccias laid in horizontal attitudes over a wide area, and by post-Miocene intrusives, have been discussed by Mr. Hague in his Presidential Address to the Geological Society of Washington, but are more fully illustrated and described in the Absaroka folio.

The Boise mining district, Idaho, attracted attention to a region which has since been the subject of surveys during several successive field seasons. Among the results is the determination of the probably post-Paleozoic age of a large granite area formerly considered to be Archean, and the elucidation of interesting episodes in the history of Snake River. A portion of these results are published in the 18th Annual as a paper entitled The Mining Districts of the Idaho Basin and the Boise Ridge, Idaho, by Waldemar Lindgren, and in the Boise folio, No. 45, and the 20th Annual contains an article entitled The Silver City, De Lamar and other Mining Districts in Idaho, by the same author. The work of the present field season is designed through reconnaissance to obtain a general knowledge of the areal geology of central and northern Idaho up to and including the Cœur d'Alene district of eastern Washington.

The desert region of Nevada south of the 40th Parallel Surveys is geologically almost unknown, and the blank in the geologic map of the United States is correspondingly extensive. Surveys are begun with the present field season to accomplish a reconnaissance of this area, extending south into southern California. If appropriations permit, it is hoped that reconnaissance surveys may, in the course of a few years, be extended over all of the little known districts of the United States, so that a complete geologic map may be published on the scale of what is known as the nine-sheet base, namely 40 miles to the inch.

The geological survey of the Sierra Nevada has been completed over an area comprising about 21,000 square miles between the 37th and 40th parallels of latitude. Twenty geologic folios have been or are to be published illustrative of the results. The work at the present time is proceeding in the Yosemite quadrangle and further south on the eastern slope of the Sierra Nevada in the Silver Peak quadrangle, which includes the Silver Peak mining district. Following the general study of the mountain range and its geologic structure, special work has been done upon some of the principal mining districts—for instance, that of Nevada City, and more recently upon the Mother Lode. For the last-named work a large-scale topographic map was prepared with great care, and Mr. Becker entered upon the studies of physics of ore deposition along the lode. In July, 1898, he was, however, diverted therefrom by an assignment to ascertain the mineral resources of the Philippines. The performance of this duty required the acceptance of a military commission, and he was attached to the Bureau of Information at Manila. Geologic investigations being precluded by the activity of the insurgents, Mr. Becker accepted his military duties with sang froid, and with the troops under fire rendered service which has been the subject of highly complimentary reports from his superior officers in the field. The information which he was able to obtain in the old Spanish bureau of mines in Manila and presumably from other reliable sources is contained in Part VI., of the 19th Annual Report.

In the Cascade Range of Washington studies conducted for the past two years with reference to the geology of the Mount Stuart quadrangle reveal a series of phenomena closely resembling those of the Sierra Nevada. The volcanic flows of which the range is composed throughout Oregon and into southern Washington give place about latitude 46° 30′ to schists and granites of pre-Tertiary age, which are unconformably overlain by sandstones of the Eocene and Miocene periods. The structure of the range cannot be said to be understood at the present time, but work is energetically proceeding with the purpose of developing the facts in such detail and so accurately as to secure conclusive information. A reconnaissance of the northern portion of the range carried out during the past summer has resulted in an article in the 20th Annual—Geology of the Cascade Mountains of Northern Washington, by I. C. Russell.

In the Coast Ranges of California and Oregon, a geologist who has acquired ideas of mountain growth from the Paleozoic rocks of the Appalachian province must completely revise his conception of that process. Where the early Cretaceous or late Jurassic rocks appear as a schistose basement complex, and the Cretaceous and Tertiary formations are separated by as many unconformities as there are distinct episodes of history, the activity of the earth's crust seems an imminent phenomenon. The contributions to the stratigraphy and structure of these youngest ranges proceed from studies in Oregon (Coos Bay Coal Field, Oregon, J. S. Diller, 19th An-

nual Report, and the Roseburg folio, Oregon, J. S. Diller), and in California from investigations by the professors of Berkeley and Stanford in the vicinity of San Francisco, and of the San Luis Obispo district, comprising the vicinity of the town of that name. At present surveys are being prosecuted on the Klamath Mountains, where strata of early Paleozoic age are identified by fossils; on a series of quadrangles which include San Francisco and a section across the Coast Range eastward to the San Joaquin Valley; and about San Luis Obispo.

In the work of the Geological Survey outside of the Appalachian province, physiography has received scant attention. The development of the mountain ranges from the Great Plains to the Pacific is recorded in physiographic forms which are as significant as facts of stratigraphy and igneous eruptions, and which continue the record made in the rocks. The physiographic province bounded by these eastern and western limits and extending from the Isthmus far into British Columbia presents problems which are as yet unconsidered. In order that they may be studied in all their breadth and comprehensiveness within the United States, Mr. Gilbert has been assigned to the investigation. The results may confidently be expected to afford an interesting group of criteria for the elucidation of mountain history, and to advance the solution of continental problems.

Petrography and paleontology, two great aids to general geologic research, have each a special purpose of investigation intimately related to other sciences. The results achieved by the specialists who are members of the Geological Survey are proportionate to the opportunities, which are broad and numerous; but in this partial and general account of the work of the Survey it is not practicable to go into details concerning them. The 19th and 20th Annuals, however, contain important contributions of general interest, namely: 'The Cretaceous Formations of the Black Hills as indicated by Fossil Plants,' by L. F. Ward; 'Status of the Mesozoic Floras of the United States,' L. F. Ward; and 'The Flora of the Pottsville Series, David White. In the 20th Annual Professor Pirsson's contribution to the petrography of the Little Belt Mountains, Montana, is an important paper.

The Division of Mineral Resources prepares a statement of the quantity and value of the products from the mines of the United States, and also special reports on new features of mining technology in relation to mineral industries. Many inquiries which come to the Interior Department in regard to questions on mineral technology of every character find their way to this division for reply. There is opportunity for development of the scope of this work in response to the agitation among mining interests for representation in the executive branch of the National government. An amendment to the Sundry Civil Bill was introduced in the Senate at the last session of Congress authorizing the Director to establish a Division of Mining in the United States Geological Survey. While the establishment of a Division of Mining was not completed by the House of Representatives, the appropriation for the work was changed from $20,000 to $30,000 and the Survey is enabled to inaugurate some of the features contemplated. For example, through cooperation with the geologic branch, there will be made a study of the conditions of occurrence of asphaltum, a mineral of constantly increasing usefulness, to secure a complete account of the various deposits in the United States. Corundum, a demand for which has become imperative in this country, will be examined in the same way. A comparison of tests as to the physical strength and chemical composition of building stones of the country, published within the last month, illustrates

the possible scope of these operations. Similar comparisons of information concerning the composition of the various fuels of the United States are urgently required, and it is proposed to undertake them.

Hydrographic Branch.—The Hydrographic Branch of the Geological Survey devotes its energies mainly to the measurement of the volume of streams, chiefly in mountainous regions. About three-fourths of the stations maintained are west of the 97th meridian, a greater portion of the remainder being in the Appalachian Mountains. In addition to the work of stream measurements systematic information regarding the methods and results of the utilization of the water supply of the country is being obtained from all sources where it can be found in the hands of individuals and corporations and published in a series of 'Water Supply and Irrigation Papers.' Geological examinations of the artesian districts of the Dakotas and of Texas are also in progress, and various problems of a scientific nature are under investigation. In connection with stream measurements the attempt is being made to measure carefully the slope of streams and to describe their regimen, in order to obtain additional information regarding the proper coefficients of friction to be used in hydrographic formulæ. The movements of underground waters are being observed by means of wells and other available sources of information, this work being chiefly done in the Great Plains region and the valleys of California. Where possible, existing information regarding artesian and surface wells is being obtained and tabulated.

The branch being charged by law with the examination and segregation of reservoir sites, those which come within the studies pursued are surveyed and segregated from private entry under the homestead and desert land laws, in order to prevent the vestment and growth of private interests which might in future be an obstacle to the best utilization of such sites.

Forestry Investigations.—The agitation for the preservation of the remaining forests of the United States resulted in the establishment of two distinct classes of work, both having reference to the forests. The one might be comprehensively described as a forest survey, its purpose being to obtain maps of the forested areas throughout the country and to set forth the present condition and future prospects of the forest reserves. The other relates to the administration of the established forest reserves, involving the appointment and supervision of numbers of rangers whose duty it is to prevent fires and depredations and to see that the laws governing the reserves are enforced.

The forest survey is in charge of the Director of the Geological Survey, and is under the immediate management of Mr. Gannett, except in so far as the topographic work, which supplies the base maps, is executed by the divisions of the Topographic Branch. It is carried out in cooperation with similar investigations conducted by the Forestry Division of the Agricultural Department under Mr. Gifford Pinchot. With the energy and capacity for broad generalizations which characterize his work, Mr. Gannett has caused the principal forest areas of the country to be investigated, and some part of the results is already published. They constitute Volume V. of the 19th Annual, and the fifth volume of the 20th Annual will also be composed entirely of papers relating to forests.

Publications Branch.—Standards of scientific and literary character were established for the textual publications of the Geological Survey early in its history. Their present style is in large measure due to the efficient work of the editor and his assistants. The magnitude of the labors of this branch can best be suggested by a state-

ment of the number of typewritten and printed pages handled during the past year. The manuscript pages, usually typewritten, amounted to 16,263, and proof sheets read and corrected during the year to 10,840; the latter, as a rule, were read twice. The editorial work increases with the growth and diversity of the Survey's work. Thus for five years, 1889 to 1894 inclusive, the number of manuscript pages edited was 46,891 and of proof pages read 22,795, whereas during the equal period from 1894 to 1899 inclusive, the corresponding numbers were 65,763 and 35,769.

The work of the Engraving Division also grows from year to year, as the output of original maps from the topographic and geologic branches is enlarged. The Chief Engraver has ingeniously simplified the technical processes, and he has organized his force on the best models of private business enterprise. The precise cost of each item of engraving, correcting, or printing is ascertainable, and the efficiency of each worker is demonstrated. To a certain extent this reacts upon the scientific branches of the Survey, since the character of original manuscripts may be such as to facilitate or to impede the work of reproduction. But in spite of efficient organization the division is not equal to the tasks imposed upon it. The publication of topographic maps (of which the number is being increased by cooperation) and the issues of geologic folios will be delayed if the appropriation for this work is not materially enlarged.

Following the precedents set under King and Powell, it has been the policy of the present Director of the Survey to secure the strongest men available for each branch of the work, and to encourage the development of individual members. Among the gratifying results of this policy was the cordial recognition of the service rendered by members of the Geological Survey, Messrs. Hayes and Davis, attached to the Nicaragua Canal Commission under Admiral Walker. In the last four years the geologic personnel has been increased by the addition of a number of strong men, recently graduated from the leading centers of geologic instruction. Several of them entered through Civil Service examination, and others, whose university work succeeded practical field experience on the Survey, came back to it after their years of study. It has been said in the course of discussions concerning a National University that the Geological Survey at present constitutes the geologic branch of such a university, since it receives post-graduate students from the highest universities in the country and gives them opportunity to pursue independent researches in geology.*

BAILEY WILLIS.

SCIENTIFIC BOOKS.

POINCARÉ'S COURS DE PHYSIQUE MATHÉMATIQUE.

Théorie du potentiel Newtonien. Par H. POINCARÉ. Rédigées par ÉDOUARD LEROY et GEORGES VINCENT. Paris, Georges Carré et C. Naud. 1899. 8vo. Pp. 366.

Cinématique et mécanismes, potentiel et mécanique des fluides. Par H. POINCARÉ. Rédigé par A. GUILLET. Paris, Georges Carré et C. Naud. 1898. 8vo. Pp. 385.

The fertility in mathematical resources of the eminent author of these volumes and the wide range of physical questions which he has illuminated by means of those resources excite at once our surprise and our admiration. He has proved, in fact, that it is still possible, as it was

* The preceding article is not intended to present a complete catalogue of the activities of the Geological Survey or of its publications. The administration, distribution of work and funds, and the assignment of the personnel, are given in detail in the Director's Annual Report, issued in December of each year, and may be had on application to the Director of the Geological Survey. Complete lists of the publications are kept as nearly up to date as possible and may be had on request.

in the days of Laplace and Gauss, for one mind to possess a working knowledge of the entire group of the mathematico-physical sciences.

An idea of the comprehensive scope of this *Cours* may be gained by the following list of titles to the preceding ten numbers of the series : 1°, Théorie mathématique de la lumière, I., 1 Vol. ; 2°, Électricité et Optique, 2 Vol. ; 3°, Thermodynamique, 1 Vol. ; 4°, Leçons sur la Théorie de l'Élasticité, 1 Vol. ; 5°, Théorie mathématique de la lumière, II., 1 Vol. ; 6°. Théorie des Tourbillons, 1 Vol. ; 7°, Les oscillations électriques, 1 Vol. ; 8°, Capilarité, 1 Vol. ; 9°, Théorie analytique de la propagation de la chaleur, 1 Vol. ; 10°, Calcul des probabilités, 1 Vol. These, together with the two works announced above, which are Nos. 11° and 12° of the series, make a total of thirteen octavo volumes devoted to at least ten fairly distinct subjects of mathematical physics. All of these volumes have appeared within a period of about ten years, during which the indefatigable author has found time also for many researches in pure mathematics and for important contributions to dynamical astronomy.*

The reader who is not already acquainted with this important series of works will naturally enquire what are its characteristic features and what are the advantages to be gained by a study of this rather formidable aggregate of three to four thousand pages of intensely mathematical literature.

In the first place, it should be said that the works are in no sense treatises. They assume, in general, a considerable knowledge of the subject on the part of the student, and do not attempt, as a rule, to give that degree of detail which is essential in an elementary presentation. Secondly, it must be said that these works are much more mathematical than physical. Indeed, it will doubtless appear to some that the title of the series ought to be Cours de mathématique physique; for the ease with which the author substitutes mathematical abstractions for physical realities is often painful to one who is at all conscious of the obstinate properties of matter. In many cases, also, the formulas dealt with are entirely divested of the factors which are indispensable to their use by the physicist; so that while the mathematical argument may proceed unimpeachably the results attained are often quite unsuited for the physical laboratory or the computer's mill. But let no mathematician who has the slightest liking for physical applications and no physicist who has a fondness for mathematical methods of research be deterred by such trifling matters of detail from an attentive study of these volumes. For the mathematician will find in them a wealth of beautiful analysis satisfying all the canons of modern precision and at the same time not obtrusively technical and practical; while the physicist, on the other hand, will be delighted and instructed by the luminous expositions of obscure questions, by the fresh and rigorous proofs of old theorems, by the more refined processes of modern analytical procedure, and by the sharper limitations of the fields explored. In short, it is one of the prime merits of these works that they afford a common ground on which the pure and applied mathematicians may meet to their mutual advantage. Of course, there must be some concessions. The pure mathematician must admit, while reading the *Cours*, at any rate, that the phenomena of nature present intricate though special and perhaps grossly utilitarian illustrations of his general theorems ; and the physicist must own, with due contrition, that it is not uninteresting and profitless, occasionally, to free one's self from the restrictions of matter, or even to investigate the imaginary properties of hypothetical mediums.

The volume devoted to the Thèorie du potentiel Newtonien is chiefly concerned with the properties and application of the function dependent on the law of the inverse square of the distance, but considerable attention is given also to the logarithmic potential, which has come to play an important rôle in some physical problems. The book is divided into nine chapters. The first deals with the potential at a point external to the attracting mass, with the equation of Laplace and with the harmonic developments of the potential function. The second is concerned with the potential at a point internal to the attracting mass, and with the equation of Poisson. The third is devoted to the potential

* Especially his 'Nouvelles théories de mécanique céleste.'

due to surface and line distributions of mass. The fourth and fifth are occupied with the function of Green and the problem of Dirichlet. The sixth gives an exposition of the potential theory as applied to double strata (double couches); that is, two infinitely near surface or stratum distributions of equal but opposite densities. The seventh and eighth continue the consideration of the problem of Dirichlet, the former by means of the process of Green's equivalent stratum (here called La methode du balayage), and the latter by the method of Neumann. The ninth chapter is devoted to an extension of the method of Neumann to the case of simply connected regions, and to certain functions (called Fonctions fondamentales) which conform to the conditions of the potential function due to a simple surface distribution of mass.

The treatment of the subject, except for the few final pages in which the 'fonctions fondamentales' are discussed, is very precise from the purely mathematical point of view. "J'ai cherché," the author says, p. 348, "à donner partout à mes raisonnements un charactère de parfait rigueur." For this reason the work will doubtless prove most interesting to the mathematician and most instructive to the physicist. But the latter can hardly conceal the regret that his demands for precision are not equally met. Thus, to cite some illustrations, the Newtonian potential is defined by the equation

$$V = \Sigma \frac{m}{n},$$

where m is any element mass and r its distance from the attracted mass; and we are told that the components of attraction in the coordinate directions are

$$X = \frac{\partial V}{\partial x},\ Y = \frac{\partial V}{\partial y},\ Z = \frac{\partial V}{\partial z};$$

but not a word is said about the gravitation constant nor of the difficulties a reader who may know the dimensions of force may have in interpreting $\partial V/\partial x$, etc. Again, how do 'potentiel newtonien d'une surface sphérique homogène' and 'potentiel logarithmique d'une circonférence' sound to one whose imagination is always shocked by the suggestion of surface and line distributions of real matter? Again, on p. 215, ξ, η, ζ figure as components of a velocity, but on p. 217 the author says: "Supposons maintenant que le vecteur ξ, η, ζ soit, en chaque point, normal à la surface, c'est-a-dire que l'on ait:

$$\xi = a,\ \eta = \beta,\ \zeta = \gamma,$$

a, β, γ désignant les cosinus directeurs de la normale au point x, y, z." The reader will find out, of course, sooner or later, how to remove these inconsistencies, but it would have been very easy to avoid them entirely and to have thus fulfilled the requirements of the physicist as well as those of the mathematician.

English students of the theory of the potential will be glad to find good French authority for the term Laplacian as applied to the sum of the three second derivatives of the potential with respect to the coordinate directions. Thus, for example, the author writes, p. 118, "Le laplacien ΔV, more commonly written $\Delta^2 V$ or $\nabla^2 V$ by English writers, 'fait un saut brusque. . ."

The most important technical features of the book are to be found in the investigations of the potential of single and double surface distributions, in the considerable space devoted to the logarithmic potential, and in the thorough though tedious treatment of the problems of Green and Dirichlet.

The volume on kinematics, potential and hydromechanics presents an unusual though not incongruous combination of subjects. A good knowledge of kinematics and a considerable acquaintance with the potential theory are, in fact, necessary preliminaries to the study of the mechanics of fluids.

Over half of the book, 200 pp., is devoted to kinematics and mechanism. Beginning with the elements of the subject, Chapter I treats of the rectilinear and curvilinear motions of a point, Chapter II of the coplanar motion of an invariable figure, Chapter III of the motions of a rigid body, Chapter IV of helicoidal motions (theory of screws), Chapter V of the relative motion of a point, and Chapter VI of the motions of various forms of mechanisms, including belts, gearing, links, etc. In the development of the purely kinematical principles the author supplies both geometrical and analytical proofs. Many of the former and some of the latter appear to follow new lines in this

well gleaned field. This work does not seem to be, as a whole, very satisfactory, however, in view of the heavy drafts which kinetics and some branches of applied mechanics now make on kinematics. A more condensed and a more analytical treatment would have been clearer, we think, and would have left room for some important generalities omitted, especially such as are essential in hydrokinetics, in elasticity, and in the kinetics of non-rigid bodies. There is in this part also an occasional departure from the modern demands for mechanical precision, as on pp. 10, 11, where, by the unnecessary suppression of a length symbol, the ancient fallacies of the equality of linear and angular velocities and of linear and angular accelerations are revived. Again, to cite another illustration of a lack of clearness, in Chapter V, which is entitled 'Mouvement relatif d'un point,' and which considers the motion of a point referred to two sets of rectangular axes, one of which moves in any manner with respect to the other, the author says, p. 121: "On peut avoir à considérer trois mouvements : 1° le mouvement du point M par rapport aux axes fixes ou mouvement absolu ; 2° le mouvement des axes mobiles ou mouvement d'entraînement; 3° le mouvement de M tel qu'il apparaîtrait à un observateur invariablement lié aux axes mobiles ou mouvement relatif." This shows also, among other things, that it is still easy to speak of the absolute even in mechanics.

The second part of the book presents, in the first two chapters, a rather elementary introduction to the theory of the force function, potential function and the flux of force, and to Green's theorem and Dirichlet's problem. There is added, also, in the third chapter, an elementary investigation of the attraction of ellipsoidal shells and of a homogeneous ellipsoid.

The most interesting and important chapters of the book are the last two, which are devoted to hydromechanics. The treatment is confined to the ideal case of perfect fluids and is, on the whole, elementary. About 60 pages are given to the theory and applications of the principles of hydrostatics. Most prominent and important among the applications is the somewhat extended discussion of the conditions of equilibrium of floating bodies. Among many instructive results it is shown that a right homogeneous cylinder may float in stable equilibrium in four different positions, in one of which its axis is vertical, in one horizontal, while in the other two the axis is oblique to the vertical.

The final chapter, of 61 pages, is devoted entirely to hydrokinetics. Proceeding from the Lagrangian to the Eulerian equations of motion, the author develops the elements of the subject with unusual clearness and mathematical elegance. After the introduction and definition of the velocity potential the theorem of Lagrange —once a potential always one—is demonstrated by an apparently new proof, which seems peculiarly well adapted to show the meaning and limitations of the theorem. The beautiful and very important theorem of Bernoulli is also demonstrated in a new and rigorous fashion. The part of the chapter dealing with irrotational motion closes with an exposition of the motion of liquids under gravity in the case wherein the products of the component velocities and their space derivatives can be neglected.

The rest of the chapter is concerned chiefly with vortex motion (vortices, tourbillons). Here also there is much fine mathematical work, though the notation is in some respects repulsive and though the printer would appear in some places to have sown his d's and ∂'s broadcast. On pp. 348–353 there is some especially interesting work preliminary to the proof of Helmholtz's theorem that the molecules once observed to be on a vortex line remain on it. This work consists in the proof of three special theorems drawn from the general equations of rotational motion for the particular case of steady motion. Let at any point x, y, z of the fluid

$$E = -T - V - \int \frac{dp}{\rho}$$

where T and V are the kinetic and potential energies respectively per unit mass, p is the pressure, and ρ is the density assumed to be dependent on p only. Then: 1st, for steady irrotational motion, for which the component spins and accelerations of the molecules vanish, it appears at once that E is constant throughout the mass, which is Bernoulli's theorem generalized; 2d, when the motion is steady but ro-

tational, E is constant along the same stream line (filet) defined by the equations

$$\frac{dx}{u}=\frac{dy}{v}=\frac{dz}{w},$$

where u, v, w, are the component velocities of the particle; 3d, when the motion is steady but rotational, E is also constant along the same vortex line, defined by the equations

$$\frac{dx}{p}=\frac{dy}{q}=\frac{dz}{r},$$

where p, q, r are the component spins.

Then follow a proof of the theorem of Helmholtz, above cited, and of the theorem that in the case of a liquid filling a recipient the velocity components u, v, w are determinate if the spins p, q, r are known at any instant. Several very instructive special cases of vortex motion are also considered; and the chapter closes with an exposition of the problem of the motion of a solid in a liquid, application being made especially to the case of pulsating spheres studied by Bjerknes. R. S. W.

The Elements of Vital Statistics. By ARTHUR NEWSHOLME, M. D. Third Edition. London, T. Swan Sonnenschein & Co., and New York, The Macmillan Company. 1899. Pp. xii + 353.

That a third edition of this book has been demanded within ten years of its first appearance is gratifying evidence of a growing public interest in Vital Statistics and an appreciation of sound and careful work. Vital Statistics, interpreting that phrase in a somewhat larger sense than is done by this writer, is probably the best avenue along which to approach the general field of statistics. It is the oldest, most developed and most systematized branch of the subject, and, if properly handled, can be made of great interest even to beginners. For these reasons I have long felt that the book of Dr. Newsholme was, perhaps, as good an introduction to statistics as anything in the English language. There is no American book to be compared with it, for the articles by Dr. J. S. Billings and Dr. Roger S. Tracy are buried in pages of other matter, one in a medical journal and the other in an encyclopædia, and neither vies in simplicity or fullness of treatment with the present work. This third edition is almost a new book, embracing fewer tables, more graphic illustrations, more references to results obtained in foreign countries and many new subjects. From the American standpoint it may be criticised as confined somewhat too closely to topics which especially interest English sanitary and medical statisticians. But as England is *facile princeps* in this field and the United States as a whole is inferior, not merely to those countries of Europe with which we naturally compare ourselves, but even to Russia, Greece, Spain and the colonies of Australia, the objection is not a serious one. During years of critical use of Dr. Newsholme's book I have never found in it a serious error of statement and the argumentative parts are sound, temperate and convincing. It is a typically English book, caring little for theory or refinements of analysis unless they have a clear bearing on the results, but strong in all such practical discussions as statistical evidence for the utility of vaccination, causes of infant mortality, or the fallacies to which statistical arguments are exposed. WALTER F. WILLCOX.

CENSUS OFFICE.

BOOKS RECEIVED.

Anatomie des Frosches. A. ECKERT and R. WIEDERSHEIM. Revision by DR. ERNEST GAUPP. 2d Edition. Braunschweig, Friedrich Vieweg und Sohn. 1899. 2d Part. Pp. 237–548 + xii.

Praxis und Theorie der Zellen-und Befruchtungslehre. VALENTIN HÄCKER. Jena, Gustav Fischer. 1899. Pp. viii + 260. Mark 7.

Fixirung, Färbung und Bau des Protoplasmas. ALFRED FISCHER. Jena, Gustav Fischer. 1899. Pp. x + 362. Mark 11.

Folk-lore in Borneo. WILLIAM HENRY FURNESS. Wallingford, Pa., Privately Printed. 1899. Pp. 30.

Sewage Analysis. J. ALFRED WANKLYN and WILLIAM JOHN COOPER. London, Kegan, Paul, Trench, Treübner & Co., Ltd.; Philadelphia, J. B. Lippincott Company. 1899. Pp. xvi + 220. $2.00.

New Plane and Solid Geometry. WOOSTER WOODRUFF BEMAN and DAVID EUGENE SMITH. Boston, Ginn & Company. 1899. Pp. ix + 382.

SOCIETIES AND ACADEMIES.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—PRELIMINARY PROGRAMS.

SECTION A, MATHEMATICS AND ASTRONOMY.

'REPORT on Progress in Non-Eulidean Geometry,' George Bruce Halsted, University of Texas, Austin, Texas.

'Report on recent progress in the theory of linear groups,' L. E. Dickson, University of California, Berkeley, Cal.

'Recent advances in the application of mathematics to physical problems,' A. S. Hathaway, Rose Polytechnic Institute, Terre Haute, Ind.

'Recent progress in theoretical meteorology,' Cleveland Abbe, Weather Bureau, Washington, D. C.

'Recent progress in positional astronomy,' J. R. Eastman, Andover, N. H.

'Practical astronomy during the first half of the present century,' T. H. Safford, Williamstown, Mass.

'Internal forces that generate stellar atmospheres,' J. Woodbridge Davis, New York City.

'The determination of the nature of electricity and magnetism, including a determination of the density of the ether,' R. A. Fessenden, Western University, Allegheny, Pa.

'Ancient eclipses and chronology,' R. W. McFarland, Oxford, Ohio.

'Some points in the design of a spectroscope,' H. C. Lord, Ohio State University, Columbus.

'The relation between point and vector analysis,' J. V. Collins, Stevens Point, Wis.

'William Hamilton, Hermann Grassmann und deren Widersacher,' Ferdinand Kraft, Zurich.

'The theory of mathematical inference,' G. J. Stokes, Queen's College, Cork, Ireland.

'The magnetic work of the Coast and Geodetic Survey,' L. A. Bauer, Coast and Geodetic Survey, Washington, D. C.

SECTION G, BOTANY.

Vice-Presidential Address, Charles R. Barnes.

'Division of the megaspore of Erythronium,' John H. Schaffner.

'The embryo-sac of Leucocrinum montanum,' Francis Ramaley.

'The occurrence of Lignum and Calcium Oxalate during differentiation of the buds of Prunus americana,' H. C. Bolley.

'The flora of Franklin County, Ohio,' A. D. Selby.

'Studies of the vegetation of the high plains of western Nebraska,' C. E. Bessey.

'The geotropism of the Hypocotyl of Cucurbita,' Edwin Bingham Copeland.

'Notos on the long-leaved (Longifoliæ) Willows,' W. W. Rowlee.

Sullivant Day—Papers on bryological subjects, especially relating to the work of Sullivant and the progress in bryology since his time. Exhibition of his type specimens, collections, publications, portraits and other mementos.

'On the occurrence of the black rot of cabbage in Europe,' H. A. Harding.

'Duration of bacterial existence under trial environments,' H. C. Bolley.

'Cultures of Uredineæ in 1899,' J. C. Arthur.

'Field experiments with 'Nitragin' and other germ fertilizers,' Byron D. Halsted.

'Some notes on subterranean organs,' A. S. Hitchcock.

'The Tamarack Swamps in Ohio,' A. D. Selby.

'Some monstrosities in spikelets of Eragrostis and Setaria with their meaning, W. J. Beal.'

'Botanical Teaching in the Secondary Schools,' W. C. Stevens, Ida Clendenin.

'Suggestions looking toward a more rational basis for the classification of the Pleurocarpous Mosses,' A. J. Grout.

'Basis for generic and specific characters in the Uredineæ,' J. C. Arthur.

'Two diseases of Juniperus caused by Trametes pini and Polyporus carneus,' Herman Von Schrenk.

'The effect of hydrocyanic acid gas upon the germination of seeds,' C. O. Townsend.

'Physiological effect of hydrocyanic acid gas upon young fruit trees,' W. G. Johnson.

'Are the trees advancing or retreating upon the Nebraska plains?' C. E. Bessey.

'Etiolative Reactions,' Wm. B. Stuart.

'The Mycorhiza of Tipularia,' Julia B. Clifford.

'Cytological studies in the Hepaticæ,' Bradley M. Davis.

'A thousand miles for a fern,' C. E. Bessey.

'The distribution of lichens in the Mississippi Valley,' B. E. Fink.

DISCUSSION AND CORRESPONDENCE.

THE FOEHN WINDS OF SWITZERLAND.

MR. WARD'S review, in SCIENCE of July 21st, of Billwiller's classification of the *Foehn* winds

is very interesting and instructive. Attention should, however, be called to the fact that the correct name is not *Foehm* (*Föhm*), as it there appears, but *Foehn* (*Föhn*), or *Foen* (*Fön*), the form with *h* being preferred. *Foehn* is derived probably from the Italian *favonio*, which in turn is from the Latin *favonius*, the name of a gentle *west* wind. Hence the Italian west wind becomes a Swiss south wind. In Latin and Italian the word is masculine; in German it is usually treated as masculine, but Grimm quotes an interesting passage from an old gloss in which it is used as feminine. The character of this wind is as uncertain as the gender, the etymological meaning being 'the favoring one,' but the following extracts translated from Schiller's William Tell show how the Swiss on Lake Lucerne dread the *Foehn*, 'the mighty spirit,' as it has been called. Ruodi, the fisherman, exclaims: "The *Foehn* has broken loose; you see how wild the lake is. I cannot steer against storm and waves." Baumgarten answers: "God help you! How I pity you!" In another place Tell says: "When the *Foehn* sweeps down from its ravines, the people put out their fires, and the boats hastily seek the harbor." Extinguishing the fires is still a custom, even a law in some parts of Switzerland—in Uri, for instance, which is especially exposed to the violence of the *Foehn*.

CHARLES BUNDY WILSON.
THE UNIVERSITY OF IOWA,
DEPARTMENT OF GERMAN.

THE OPENING OF THE MOUTH AS EXPRESSION.

TO THE EDITOR OF SCIENCE: Charles Darwin ascribed the open mouth in surprise and astonishment to several causes, viz., for quietness and effectiveness of breathing, and by mere relaxation of muscles. It occurs to me that a deeper organic reason may have its force, namely, that the open mouth is attention sign, and is a primitive and constant reaction with the young of many animals for the reception of food—for example, with birds. Any sound or other stimulus immediately causes the young bird to extend its mouth. I have some evidence that with very young infants every stimulus of sound or sight causes opening of the mouth, often in sucking form, and the smile of the infant when the finger is pointed at it may be either nascent or degraded sucking. The common and highly useful tendency of the very young to open the mouth to all stimuli, visual, aural, etc., continues as a survival in after life, being especially brought out with stimuli of high intensity and unusual quality, and thus becomes a mark of surprise and astonishment. It is also noteworthy that with many young boys and girls there is a tendency to open the mouth under any attention. The rise of smiling and laughter as connected with wit and humor—at the basis of which lies surprise—is thus evident as a kind of attention expression. Certainly the primary expression of the mouth is a feeding expression, and that this has been modified and evolved in connection with a variety of attention phenomena seems probable, and it would be worth while to make a very detailed study of expression in infants and young animals with this point in view.

HIRAM M. STANLEY.
LAKE FOREST, ILL., August 8, 1899.

ASTRONOMICAL NOTES.

OBSERVATORY OF YALE UNIVERSITY.

THE annual report of this observatory states that the heliometer has been used for making the final measures of the parallax series of stars having large proper motion. The study of the refraction of highly colored red stars has been continued. The photographic observations of the meteors in November, 1898, gave sixteen trails, eight of which were of Leonids. Four of these were in plates at both of the stations occupied. Dr. Elkin has published in the *Astrophysical Journal* a careful discussion of the position of the radiant obtained from the trails.

FLOWER OBSERVATORY OF THE UNIVERSITY OF PENNSYLVANIA.

VOL. I., Part II., of the publications of this observatory contains the discussion of the zenith telescope observations—October 1, 1896–August 16, 1898. The plan of this work for investigating the variation of latitude is that proposed by Küstner in 1890 and has been most zealously and carefully carried out by Professor Doolittle. The groups of stars, each of which is included in about two hours of right ascen-

sion, are so arranged that one group culminates in the evening and another in the morning hours. The range of the variation in latitude, given in the final corrected results, is 0″.44, and the probable error of a single determination is 0″.134. Two maxima and minima are covered in the period of observations, the range of the maximum and minimum in the middle of the series being somewhat less than the extreme range. Among the interesting details brought out in the critical discussion are: that the value of the micrometer screw is variable from other causes than change of temperature; that the deduced constant of aberration is unexpectedly large, viz., 20″.580, and that the same pairs of stars gave results on different nights which differed occasionally by many times the computed probable error of the observation. No satisfactory explanation of this anomaly has been found. The corresponding anomaly in longitude work is plausibly explained by variation in personal equation of the observers, but it is not easy to apply this explanation to zenith telescope observations.

CHAMBERLIN OBSERVATORY OF THE UNIVERSITY OF DENVER.

Professor Howe continues to make micrometric observations of superior excellence with the Bruce micrometer attached to the 20-inch equatorial. His careful work upon the fainter nebulæ has been embodied in two communications to the Royal Astronomical Society which are published in Monthly Notices, Vol. LVIII., Nos. 6 and 9. The extensive series of observations of Eros from September 12, 1898, to April 6, 1899, is given in the *Astronomical Journal*, No. 463.

ASTRONOMICAL OBJECTIVES.

Zeiss's new catalogue calls attention to the improvements in objectives which have resulted from recent studies encouraged by the varieties of glass manufactured at Jena. The price lists include six or more special combinations having individual excellences. The binary apochromatic lens with ratio of aperture to focal length 1:17 to 1:20 nearly eliminates the secondary spectrum, as does König's combination of one flint and two crown of shorter focus (ratio 1:10 to 1:15) which is styled the triple apochromatic lens. The ordinary silicate glasses are used as heretofore with long focus (ratio 1:15 to 1:18) by Fraunhofer's formula, and there is also a lens of longer focus especially adapted for astro-photographic purposes. Short-focus lenses are represented by a triple lens with ratio 1:4 to 1:6 designed for finders and a binary lens with flat field, both of which have an uncorrected secondary spectrum. It would be interesting to learn how many of these special combinations will come into actual use.

Winslow Upton.

Providence, R. I.,
August 10, 1899.

NOTES ON PHYSICS.

The London *Electrician* states that on July 3d Lord Kelvin sent to the Royal Society the following in a telegram: "An electrified body is set into rotation by the generation of a magnetic field around it. The magneto-optical phenomena discovered by Faraday, Kerr and Zeeman are to be thus explained." In the next issue of the paper a letter from Lord Kelvin states that this announcement was not based on experimental results, but deduced from the current that flows in a metallic conductor at right angles to a growing magnetic field. The telegram is discussed editorially and in a letter by G. F. Fitzgerald. The point seems to be that the growth of the field will cause a displacement of the charge round the body which will be the equivalent of a momentary current, and that this reacting on the field will cause rotation, which, if the body is frictionless, will continue till the stopping of the field produces an equal opposite torque. Fitzgerald states that he has considered this matter, but doubts if the forces will be great enough to permit of experimental demonstration. In the same issue, and in connection with this matter, S. P. Thomson describes and discusses a phenomenon presented to the Royal Society by C. E. S. Phillips, in which a vacuum tube having iron electrodes which can be powerfully energized by an external electromagnet is used. When a discharge has been sent through the tube, and then cut off, even for so long as ten minutes, and then the magnets are energized, a brightly luminous ring forms normal to the field, and

rotates rapidly, the direction of rotation depending upon that of the field, but not of the discharge. This, Thomson explains by electrified molecules passing inward from the walls of the tube and set in rotation by the growing field.

In the London *Electrician* of July 7th P. A. C. Swinton describes experiments upon the incandescence of Thoria and Ceria as heated by bombardment in a vacuum tube. He states that in the Bunsen flame Thorium oxid and Cerium oxid give about the same degree of incandescence, and that the addition of one per cent. of the latter to the Thorium oxid, as in the Wellsbach mantle, increases the incandescence about eleven times. In the vacuum tube, however, the ceria was but a dull red, when the thoria was at full incandescence, and the same was true of a mixture of half and half; further the addition of the one per cent. of ceria to the thoria increased the incandescence only about five per cent. This seems to favor the theory that chemical action takes place in the action of the Wellsbach mantle. The energy used was about one watt per candle.

F. C. C.

NOTES ON INORGANIC CHEMISTRY.

Attention was recently called to the researches of Armand Gautier on the occurrence of iodin in ocean water. A continuation of his work takes up the iodin in the water of the Mediterranean Sea. The surface water, like that of the Atlantic Ocean, contains no iodids or iodates, but the iodin is present either in microscopic organisms or in complex organic compounds containing also nitrogen and phosphorus and capable of dialysis. The total amount of iodin present is the same for all depths, but varies in its form. Thus at the bottom of the sea iodids and iodates are present to the extent of 0.305 milligrams per liter, while they are zero at the surface. Of iodin in living organisms there is a maximum at the surface and none at the bottom. The soluble organic iodin is more constant, though varying to some extent with a maximum at 880 meters depth. The total iodin present is 2.25 mg. per liter, which is but little less than the 2.40 mg. found in the water of the Atlantic Ocean.

The same number of the *Comptes Rendus* contains an account of the preliminary work by F. Garrigon on the occurrence of rare metals in water. He finds evidence of the presence of a number of unexpected metals, particularly those of the copper and tin groups. As titanium has been found not only as a constant constituent of almost all soils by Dunnington; but of many, if not all, plants by Wait; and of animals including man — unpublished work of Wait (Univ. of Tenn.), Toole (Wash. & Lee.), and Baskerville (Univ. of N. C.)—it is not unnatural that traces of it should be found in mineral waters.

One of the greatest drawbacks to work on the element fluorin has been that the apparatus used must be of platinum or fluor spar. Moissan has, however, now shown that copper vessels can be used even for the electrolysis of hydrofluoric acid, being less attacked than other metals. The cause of this appears to be that there is formed on the surface of the copper a very thin layer of the fluorid of copper, which is wholly insoluble in hydrofluoric acid, and, of course, unattacked by free fluorin.

Three papers have recently been read before the Chemical Society of London by Harold B. Dixon, which are of considerable interest. The first is on the combustion of carbon bisulfid. He finds it burns in the air with phosphorescence, which, however, begins to appear at 230°, while real ignition does not begin till 232° is reached. Carbon bisulfid is not decomposed by leading through a tube at 400°. It can be detonated by a heavy blow, but the explosion is not propagated through the vapor. The rapidity of explosion is greatest when exactly sufficient oxygen for combustion is present.

A second paper is on the combustion of coal. It is ordinarily accepted that carbon burns directly to carbon dioxid and that this is subsequently reduced by the excess of carbon to carbon monoxid. Professor Dixon finds that when a mixture of air and carbon monoxid is passed slowly over coal at 500° the amount of carbon monoxid is unchanged, but the oxygen disappears completely by union with carbon to form carbon dioxid. On the other hand, if a mixture of 20% carbon monoxid and 80% oxygen is used, and the current is very slow, the

amount of carbon monoxid in the end product is increased. This is interpreted to mean that the primary combustion product at 500° is not exclusively at least carbon dioxid. Dixon is of the opinion that both carbon monoxid and carbon dioxid are formed at 500° and that in each instance there is sufficient heat of formation to occasion a secondary reaction, in the one case with oxygen, in the other with carbon.

THE third paper is on the action of nitrogen monoxid on nitrogen dioxid, in which the conclusion is drawn from experiments that, contrary to the views of Lunge and others that N_2O_3 cannot exist in the gaseous state, NO and NO_2 do unite to a limited degree to an unstable compound, which is the more dissociated the higher the temperature. The reaction $N_2O_3 \gtrless NO + NO_2$ is reversible and the properties of the mixed gases thus accounted for.

IN the same number of the *Proceedings of the Chemical Society* Szarvasy and Messinger describe a new compound of arsenic and tellurium. Proceeding from the fact that the difference in molecular weight of the arsenic compounds of the sixth group, As_2O_3, As_2S_2, As_2Se, is 15-16 units, they calculated that the tellurium compound should have the formula As_8Te_3, and accordingly fused together the components in this proportion under pressure and determined the properties and vapor density of the resulting compound.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

PRESIDENT SCHURMAN, of the Philippine Commission, has returned to the United States.

DR. A. B. MEYER, Director of the Dresden Museums, is now in the United States on a commission from the Saxon government to inspect American museums before the new buildings are erected at Dresden. He is accompanied by Professor P. Wallot, who is one of the international commission of architects selected to decide on the plans of the University of California in accordance with Mrs. Hearst's arrangements.

THE Duke of Bedford has been elected President of the Zoological Society of London, in the room of the late Sir William Flower.

THE Baly gold medal of the Royal College of Physicians, London, awarded for distinguished services to physiology, has been conferred upon Dr. C. S. Sherrington, F.R.S., professor of physiology in University College, Liverpool.

MR. G. A. STONIER, formerly Geographical Surveyer for New South Wales, has been appointed specialist in mining under the Geological Survey of India.

MR. EUSTACE GURNEY, of New College, has been appointed by Oxford University to the University Table at the Naples Biological Station.

AN aid in cryptogamic botany in the Smithsonian Institution, at a salary of $75 a month, will be appointed as a result of a civil service examination to be held on November 5th and 6th.

DR. J. WEINGARTEN, professor of mathematical physics in the Technical School of Berlin, has been elected a foreign member of the Accademia dei Lincei at Rome.

COLONEL HEINRICH HARTL, professor of geography in the University of Vienna, has been made an honorary doctor by the University.

PROFESSOR GUIDO CORA, of Rome, has been elected a member of the Italian Council of Geodesy.

W. D. HUNTER, Assistant Entomologist of the Experiment Station of the University of Nebraska, has been given a month's leave of absence in order to act as Special Agent for the Division of Entomology of the United States Department of Agriculture. He is to investigate the locusts of Minnesota and North Dakota.

AVEN NELSON, Botanist of the Wyoming Station, left Laramie early in June on an extended botanical survey of the Yellowstone National Park and the adjacent forestry reserves. In addition to large collections of the entire flora a careful study of the forage plants and range conditions is contemplated.

WE learn from the *Botanical Gazette* that the botanical plans of the University of Iowa for the summer are as follows: Professor B. Shimek will be engaged in special studies of the forestry problems in Iowa, under the direction of the

U. S. Department of Agriculture; Mr. T. E. Savage will probably complete his studies of the mosses and Hepaticæ of the State; Mr. P. C. Myers will complete a photographic record of the diatoms of Iowa, recent and fossil, and Professor T. H. Macbride will probably spend the summer in the Grand Cañon of the Colorado, studying the forest problems there for report to the United States Department of Agriculture, and incidentally collecting the fungi of the region.

THE Società Bibliografica Italiana has unanimously adopted a resolution declaring that the project of the Committee of the Royal Society of London on an International Catalogue of Scientific Literature is impracticable viewed from the financial standpoint and is open to grave objections from the bibliographic standpoint. The Society has petitioned the Italian government, in view of the new international conference, which is to decide definitely, to add to its official representative technically competent persons who would be in a position to point out the practical and technical difficulties of the present project.

DR. LEO ARONS, privatdocent for physics in the University of Berlin, against whom a complaint was lodged by the Ministry for belonging to the Social Democratic party, has been acquitted by the philosophical faculty of the University.

MR. BEREND BESSEL LORCK, of London, has presented to the Berlin Academy of Sciences a large number of letters addressed to his grandfather, Friedrich Wilhelm Bessel. There are in all 2,946 letters addressed to Bessel by 234 different men of science and artists, including the leading contemporary astronomers. The Academy already possessed 106 letters addressed by Bessel to Struve and now receives 106 letters addressed by Struve to Bessel.

WE learn from *Natural Science* that the Manchester Museum has acquired the Dresser collection of birds. It contains about 10,000 specimens and is especially rich in palearctic specimens.

THE British Medical Association commenced its annual meeting at Portsmouth, on August 1st. The President, Dr. J. Ward Cousins, chose as the subject of his opening address 'The Century's Progress in Medicine and Surgery.' It was reported by the Treasurer that during the year £49,000 had been paid for their new premises on the Strand; the revenue for the year amounted to £42,924.

THE Sixth International Agricultural Congress will be held at Paris from the 1st to the 8th of July, 1900. The sections will be as follows: (1) rural economy (agricultural credit, agricultural associations, land surveying, agrarian questions); (2) agricultural education (experimental stations, field experiments, etc.); (3) agricultural science (application of science to agriculture, agricultural improvements); (4) live stock; (5) practical agriculture (industrial crops and agricultural industries); (6) special crops of the south (silk production, early fruit and vegetables, perfume plants and colonial productions); (7) injurious insects and parasites (international measures for the protection of useful animals).

A CORRESPONDENT has sent us this proposed inscription for the statue of Darwin: "Charles Darwin, the great naturalist, whose book on the 'Origin of Species' revolutionized the course of human thought. His carefulness in investigation was only equalled by his genius, and only surpassed by his uprightness of character." It is also suggested that the best inscription would be simply 'Charles Darwin.'

THE Natural History Museum, London, has set aside one of the alcoves in the Central Hall for the exhibition of specimens recently acquired. According to *Natural Science* the following have been on view: Fish, mollusca and other invertebrata, from Lake Tanganyika, collected by Mr. J. E. S. Moore, illustrating the marine origin of the fauna and its antique character. Fish from the River Congo, described by Mr. Boulenger (*Annales Mus. Congo*), and presented by the Secretary of State of the Congo Free State. *Lepidosiren paradoxa*, collected in the Paraguayan Chaco by Mr. J. Graham Kerr. A collection of rare birds from Patagonia and Argentina, presented by Dr. F.P. Moreno, Director of the La Plata Museum. A fine collection of Hexactinellid sponges from Japan. A male

Cervus sica manchuricus in full summer coat—a splendid specimen, presented by the Duke of Bedford. And a large specimen of the Tarpon fish, *Megalops thrissoides*, captured off Florida by Mr. Otis A. Mygatt, and presented by H.R.H. the Prince of Wales.

UNIVERSITY AND EDUCATIONAL NEWS.

We are informed that the following doctorates were conferred last year in addition to those published in the issue of August 4th. At Northwestern University, Mr. Charles Hill was given the degree of Doctor of Philosophy with a thesis entitled 'Developmental History of the Primary Segments of the Vertebrate Head,' and at the University of Minnesota, Mr. Francis Ramaley, now professor of biology in the University of Colorado, was given the degree for work in plant morphology.

The two veterinary colleges situated in New York City have been consolidated under the name of the New York American Veterinary College and School, and this has been made a part of the New York University. Dr. A. F. Liantard has been appointed Dean.

Two fellowships in pathology have been established in McGill University. They are of the value of $500 per annum, and the holders may be required to assist in directing laboratory work to the extent of 12 hours a week.

The reorganization and separation of the faculties of the two Colleges, 'Letters' and 'Industrial,' hitherto constituting the 'General Faculty' of the University of Nebraska,' has been referred to a committee consisting of the Deans of the Colleges and the Acting Chancellor of the University, to report to the Regents at the semi-annual meeting in December. Dr. Ellery W. Davis has been appointed Chairman of the Industrial College Faculty and Acting Dean of the Industrial College.

At a recent meeting of the Regents of the University of Nebraska bids were accepted for the erection of an Experiment Station building for $21,332 and a power plant for $2,947. Provision has also been made for certain chemical work in the sugar beet experiments in progress at Ames, Nebraska.

The Council of the University of Paris has fixed the fees for those studying for the doctorate as follows: Annual matriculation, 20 fr.; library, 10 fr.; fees for laboratories, 200–800 fr.; examination, 140 fr.

Professor Henry G. Jesup, since 1877 professor of botany in Dartmouth College, has resigned.

Dr. August L. Rimbach (Ph.D., Jena, 1887), of Jena, Germany, has been appointed instructor in vegetable physiology and pathology in the University of Nebraska, He was professor of botany and zoology in the University of Cuenca, Ecuador, from 1889 to 1894, after which he spent nearly two years in botanical travel in the Andes and along the Pacific coast of tropical South America. More recently he has given his time to botanical researches in Germany. These have been chiefly physiological and ecological, and the results have appeared in numerous papers in the German botanical journals.

Professor E. A. Burnett, of the Agricultural College of South Dakota, has accepted the chair of animal husbandry in the University of Nebraska, and will resume the duties of his new position at the opening of the fall semester. Mr. Abel A. Hunter has been appointed botanical collector for the University.

Mr. H. G. Timberlake, of the University of Michigan, has been appointed instructor in botany in the University of Wisconsin, and Mr. G. T. Moore, of Harvard University, has received a similar appointment at Dartmouth College.

Dr. E. H. Starling, F.R.S., has been elected to the Jodrell professorship of physiology in the University of London, in succession to Professor Schäfer, who, as we have already stated, has accepted a call to Edinburgh.

Dr. Sutherland, assistant professor of pathology at Glasgow, has been appointed professor of pathology at St. Andrews, in the place of Professor Muir, recently appointed professor of pathology at Glasgow.

SCIENCE

FRIDAY, AUGUST 25, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*A PROBLEM IN AMERICAN ANTHROPOLOGY.**

WHILE engaged in writing the address which I am to read to you this evening the sad news reached me of the death, on July 31st, of our President of five years ago, Doctor D. G. Brinton. Although not unexpected, as his health had been failing since he was with us at the Boston meeting, where he took his always active part in the proceedings of Section H and gave his wise advice in our General Council, yet his death affects me deeply. I was writing on a subject we had often discussed in an earnest but friendly manner. He believed in an all-pervading psychological influence upon man's development, and claimed that American art and culture were autochthonous, and that all resemblances to other parts of the world were the results of corresponding stages in the development of man; while I claimed that there were too many root coincidences, with variant branches, to be fully accounted for without also admitting the contact of peoples. Feeling his influence while writing, I had hoped that he would be present to-night, for I am certain that no one would have more readily joined with me in urging a suspension of judgment, while giving free expression to opinions, until the facts have been worked over anew and more knowledge attained.

* Address of the retiring President of the American Association for the Advancement of Science, given at Columbus on August 21, 1899.

His eloquent tongue is silent and his gifted pen is still, but I urge upon all who hear me to-night to read his two addresses before this Association: one as Vice-President of the Anthropological Section in 1887, published in our 36th volume of *Proceedings;* the other as retiring President in 1895, published in our 44th volume. In these addresses he has, in his usual forceable and comprehensive manner, presented his views of American anthropological research and of the aims of anthropology.

Dr. Brinton was a man of great mental power and erudition. He was an extensive reader in many languages and his retentive memory enabled him to quote readily from the works of others. He was a prolific writer, and an able critic of anthropological publications the world over. Doing little as a field archæologist himself, he kept informed of what was done by others through extensive travels and visits to museums. By his death American anthropology has suffered a serious loss, and a great scholar and earnest worker has been taken from our Association.

In the year 1857 this Association met for the first time beyond the borders of the United States, thus establishing its claim to the name American in the broadest sense. Already a member of a year's standing, it was with feelings of youthful pride that I recorded my name and entered the meeting in the hospitable city of Montreal; and it was on this occasion that my mind was awakened to new interests which in after years led me from the study of animals to that of man.

On Sunday, August 16th, while strolling along the side of Mount Royal, I noticed the point of a bivalve shell protruding from roots of grass. Wondering why such a shell should be there and reaching to pick it up, I noticed, on detaching the grass roots about it, that there were many other whole and broken valves in close proximity —too many, I thought, and too near together to have been brought by birds, and too far away from water to be the remnants of a musk-rat's dinner. Scratching away the grass and poking among the shells, I found a few bones of birds and fishes and small fragments of Indian pottery. Then it dawned upon me that here had been an Indian home in ancient times and that these odds and ends were the refuse of the people—my first shell-heap or kitchen-midden, as I was to learn later. At the time, this was to me simply the evidence of Indian occupation of the place in former times, as convincing as was the palisaded town of old Hochelaga to Cartier when he stood upon this same mountain side more than three centuries before.

At that meeting of the Association several papers were read, which, had there been a Section of Anthropology, would have led to discussions similar to those that have occurred during our recent meetings. Forty-two years later we are still disputing the evidence, furnished by craniology, by social institutions and by language, in relation to the unity or diversity of the existing American tribes and their predecessors on this continent.

Those were the days when the theory of the unity of all American peoples, except the Eskimo, as set forth by Morton in his 'Crania Americana' (1839) was discussed by naturalists. The volumes by Nott and Gliddon, 'Types of Mankind' (1854) and 'Indigenous Races of the Earth' (1857), which contains Meigs' learned and instructive dissertation, 'The Cranial Characteristics of the Races of Men,' were the works that stirred equally the minds of naturalists and of theologians regarding the unity or diversity of man—a question that could not then be discussed with the equanimity with which it is now approached. The storm caused by Darwin's 'Origin of Species' had

not yet come to wash away old prejudices and clear the air for the calm discussion of theories and facts now permitted to all earnest investigators. Well do I remember when, during those stormy years, a most worthy Bishop made a fervent appeal to his people to refrain from attending a meeting of the Association, then being held in his city, on account of what he claimed to be the atheistic teachings of science. Yet ten years later this same venerable Bishop stood before us, in that very city, and invoked God's blessing upon the noble work of the searchers for truth.

At the meeting of 1857 one of our early Presidents, the honored Dana, read his paper entitled 'Thoughts on Species,' in which he described a species as "a specific amount or condition of concentrated force defined in the act or law of creation," and, applying this principle, determined the unity of man in the following words:

"We have, therefore, reason to believe, from man's fertile intermixture, that he is one in species, and that all organic species are divine appointments which cannot be obliterated unless by annihilating the individuals representing the species."

Another paper was by Daniel Wilson, recently from Scotland, where six years before he had coined that most useful word, 'prehistoric,' using the term in the title of his volume, 'Prehistoric Annals of Scotland.' In his paper Professor (afterward Sir Daniel) Wilson controverted the statement of Morton that there was a single form of skull for all American peoples, north and south, always excepting the Eskimo. After referring to the views of Agassiz as set forth in the volumes of Nott and Gliddon, he said: "Since the idea of the homogeneous physical characteristics of the whole aboriginal population of America, extending from Terra del Fuego to the Arctic circle, was first propounded by Dr. Morton it has been accepted without question, and has more recently been made the basis of many widely comprehensive deductions. Philology and archæology have also been called in to sustain this doctrine of a special unity of the American race, and to prove that, notwithstanding some partial deviations from the prevailing standard, the American Indian is essentially separate and peculiar—*a race distinct from all others*. The stronghold, however, of the argument for the essential oneness of the whole tribes and nations of the American continents is the supposed uniformity of physiological and especially of physiognomical and cranial characteristics—an ethnical postulate which has not yet been called in question."

After a detailed discussion of a number of Indian crania from Canada and a comparison with those from other parts of America, as described by Morton, Wilson makes the following statements: "But making full allowance for such external influences, it seems to me, after thus reviewing the evidence on which the assumed unity of the American race is formed, a little less extravagant to affirm of Europe than of America that the crania everywhere and at all periods have conformed, or even approximated, to one type.

"As an hypothesis, based on evidence accumulated in the Crania Americana, the supposed homogeneity of the whole American aborigines was perhaps a justifiable one. But the evidence was totally insufficient for any such absolute and dogmatic induction as it has been made the basis of. With the exception of the ancient Peruvians, the comprehensive generalizations relative to the southern American continent strangely contrast with the narrow basis of the premises. With a greater amount of evidence in reference to the northern continent, the conclusions still go far beyond anything established by absolute proof; and the subsequent labors of Morton him-

self, and still more of some of his successors, seem to have been conducted on the principle of applying practically, and in all possible bearings, an established and indisputable scientific truth, instead of testing by further evidence a novel and ingenious hypothesis."

At the close of this instructive paper are the following words: "If these conclusions, deduced from an examination of Canadian crania, are borne out by the premises, and confirmed by further investigation, this much at least may be affirmed: that a marked difference distinguishes the northern tribes, now or formerly occupying the Canadian area, in their cranial conformation, from that which pertains to the aborigines of Central America and the southern valley of the Mississippi; and in so far as the northern differ from the southern tribes they approximate more or less, in the points of divergence, to the characteristics of the Esquimaux: that intermediate ethnic link between the Old and the New World, acknowledged by nearly all recent ethnologists to be physically a Mongol and Asiatic, if philologically an American."

The third paper of the meeting to which I shall refer was by another of our former Presidents, the then well-known student of Indian institutions and the author of the 'League of the Iroquois' (1851). In this paper on 'The Laws of Descent of the Iroquois,' Morgan discusses the League as made up of five nations each of which was subdivided into tribes, and he explains the law of marriage among the tribes, the family relationship and the descent in the female line as essential to the maintenance of the whole system. He then says:

"Now the institutions of all the aboriginal races of this continent have a family cast. They bear internal evidence of a common paternity, and point to a common origin, but remote, both as to time and place. That they all sprang from a common mind, and in their progressive development have still retained the impress of original elements, is abundantly verified. The Aztecs were thoroughly and essentially Indian. We have glimpses here and there at original institutions which suggest at once, by their similarity, kindred ones among the Iroquois and other Indian races of the present day. Their intellectual characteristics, and the predominant features of their social condition, are such as to leave no doubt upon this question; and we believe the results of modern research upon this point concur with this conclusion. Differences existed, it is true, but they were not radical. The Aztec civilization simply exhibited a more advanced development of those primary ideas of civil and social life which were common to the whole Indian family, and not their overthrow by the substitution of antagonistic institutions."

After calling attention to the fact that a similar condition exists among certain peoples of the Pacific Islands, he writes: "Whether this code of descent came out of Asia or originated upon this continent is one of the questions incapable of proof; and it must rest, for its solution, upon the weight of evidence or upon probable induction. Its existence among American races whose languages are radically different, and without any traditional knowledge among them of its origin, indicates a very ancient introduction; and would seem to point to Asia as the birthplace of the system."

It would be interesting to follow the succeeding meetings of the Association and note the recurring presentation of views which the quotations I have given show to have been most seriously discussed over a generation ago. An historical review of the literature of American anthropology during the present century would also be interesting in this connection. It is probable, however, that a review of this litera-

ture for the first half of the century would reveal the fact that the writers, with here and there a notable exception, were inclined to theorize upon insufficient data and devoted little time to the accumulation of trustworthy facts. The presentation and discussion of carefully observed facts can almost be said to have begun with the second half of the century, and this is the only part of the subject that now commands serious attention.

A reference to the very latest *résumé* of this subject as presented in the 'History of the New World called America,' by Edward J. Payne, Vol. II., Oxford, 1899, is instructive here. In this volume Mr. Payne expresses his belief in the antiquity and unity of the American tribes, which he considers came from Asia in preglacial and glacial times, when the northwestern corner of America was connected with Asia, and when man "as yet was distinguished from the inferior animals only by some painful and strenuous form of articulate speech and the possession of rude stone weapons and implements, and a knowledge of the art of fire-kindling. Such, it may be supposed, were the conditions under which man inhabited both the Old and the New World in the paleo-ethnic age * * * * Even when a geological change had separated them [the continents] some intercourse by sea was perhaps maintained—an intercourse which became less and less, until the American branch of humanity became practically an isolated race, as America itself has become an isolated continent." (Preface.)

Mr. Payne discusses the growth of the languages of America, the various social institutions and arts, and the migrations of these early savages over the continent, north and south, during the many centuries following, as one group after another grew in culture. He considers all culture of the people autochthonous. "It may, however, be suggested that, as in the Old World, the earlier and the smaller tribes tend to dolichocephaly, while the better developed ones are rather brachycephalous—a conclusion indicating that the varying proportions of the skull should be taken less as original evidence of race than as evidence of physical improvement."

This volume by Mr. Payne is replete with similar statements of facts and theories, and shows how difficult it is for us to understand the complications of the subject before us. It cannot be denied that, taking into consideration the number of authors who have written on this subject, Mr. Payne is well supported in his theory of the autochthonous origin of all American languages, institutions and arts; but the question arises: Has not the old theory of Morton, the industrious and painstaking pioneer of American craniology, been the underlying cause of this, and have not the facts been misinterpreted? At the time of Morton the accepted belief in the unity and universal brotherhood of man was about to be assailed, and it seems, as we now look back upon those times of exciting and passionate discussions, that Morton may have been influenced by the new theory which was so soon to become prominent—that there were several distinct creations of species of the genus *Homo* and that each continent or great area had its own distinct fauna and flora. Certainly Morton ventured to make a specific statement from a collection of crania which would now be regarded as too limited to furnish true results.

The anthropologist of to-day would hardly venture to do more than to make the most general statements of the characters of any race or people from the examination of a single skull; although, after the study of a large number of skulls from a single tribe or special locality, he would probably be able to select one that was distinctly char-

acteristic of the special tribe or group to which it pertained.

Relatively long and narrow heads and short and broad heads occur almost everywhere in greater or less proportion. In determining the physical characters of a people, so far as this can be done from a study of crania, the index of the height of the skull is quite as important as that of its breadth. These indices simply give us the ready means of expressing by figures the relative height and breadth of one skull in comparison with another, a small part of what the zoologist would consider in describing, for instance, the skulls of the different species of the genus *Canis*. So in our craniological studies we should determine the relative position, shape and proportions of the different elements of the skull. In fact, we should approach the study of human crania with the methods of the zoologist, and should use tables of figures only so far as such tables give us the means of making exact comparisons. Here, again, are the anthropologists at a disadvantage, inasmuch as it is only very recently that we are approaching a standard of uniformity in these expressions. It is now more than ever essential that the anthropologists should agree upon a method of expressing certain observed facts in somatology, so that the conscientious labors of an investigator who has had a special opportunity for working upon one group of man may be made available for comparison by investigators of other groups.

Probably the old method, still largely in vogue, of stating averages is responsible for many wrong deductions. If we take one hundred or more skulls of any people we shall find that the two extremes of the series differ, to a considerable extent, from those which naturally fall into the center of the series. These extremes in the hands of a zoologist would be considered the subvarieties of the central group or variety. So in anthropology we should take the central group of the series as furnishing the true characters of the particular variety or group of man under consideration, and should regard the extremes as those which have been modified by various causes. It may be said that this central group is defined by stating the mean of all the characters, but this is hardly the case, for by giving the mean of all we include such extraneous characters as may have been derived by admixture or from abnormal conditions.

The many differing characteristics exhibited in a large collection of crania, brought together from various portions of America, North and South, it seems to me, are reducible to several great groups. These may be generally classed as the Eskimo type the northern and central or so-called Indian type, the northwestern brachycephalic type, the southwestern dolichocephalic type, the Toltecan brachycephalic type and the Antillean type, with probably the ancient Brazilian, the Fuegian and the pre-Inca types of South America. Each of these types is found in its purity in a certain limited region, while in other regions it is more or less modified by admixture. Thus the Toltecan, or ancient Mexican, type (which, united with the Peruvian, was separated as the Toltecan family even by Morton) occurs, more or less modified by admixture in the ancient and modern pueblos and in the ancient earth-works of our central and southern valleys. In Peru, more in modern than in ancient times, there is an admixture of two principal types. At the north of the continent we again find certain traits that possibly indicate a mixture of the Eskimo with the early coast peoples both on the Pacific and on the Atlantic sides of the continent. The north-central Indian type seems to have extended across the continent and to have branched in all directions, while a similar but not so extensive branching, northeast and south,

seems to have been the course of the Toltecan type.

This is not theorizing upon the same facts from which Morton drew the conclusion that all these types were really one and the same. Since Morton's time we have had large collections of crania for study, and the crania have been correlated with other parts of the skeleton and with the arts and institutions of the various peoples.

Although these relations have been differently interpreted by many anthropologists who have treated the subject, yet to me they seem to indicate that the American continent has been peopled at different times and from various sources; that in the great lapse of time since the different immigrants reached the continent there has been in many places an admixture of the several stocks and a modification of the arts and customs of all; while natural environment has had a great influence upon the ethnic development of each group. Furthermore, contact of one group with another has done much to unify certain customs; while 'survivals' have played an active part in the adoption and perpetuation of arts and customs not native to the people by whom they are preserved.

The Inca civilization, a forcible one coming from the north, encroached upon that of the earlier people of the vicinity of Lake Titicaca, whose arts and customs were, to a considerable extent, adopted by the invaders. It is of interest here to note the resemblance of the older Andean art with that of the early Mediterranean, to which it seemingly has a closer resemblance than to any art on the American continent. Can it be that we have here an æsthetic survival among this early people, and could they have come across the Atlantic from that Eurafric region which has been the birth-place of many nations? Or is this simply one of those psychical coincidences, as some writers would have us believe! The customs and beliefs of the Incas point to a northern origin and have so many resemblances to those of the ancient Mexicans as hardly to admit of a doubt that in early times there was a close relation between these two widely separated centers of ancient American culture. But how did that pre-Inca people reach the lake region? Is it not probable that some phase of this ancient culture may have reached the Andes from northern Africa? Let us consider this question in relation to the islands of the Atlantic. The Canary Islands, as well as the West Indies, had long been peopled when first known to history; the Caribs were on the northern coast of South America, as well as on the islands; and in the time of Columbus native trading boats came from Yucatan to Cuba. We thus have evidence of the early navigation of both sides of the Atlantic, and certainly the ocean between could easily have been crossed.

One of the most interesting as well as most puzzling of the many phases of American archæology is the remarkable development of the art of the brachycephalic peoples, extending from northern Mexico northeastward to the Mississippi and Ohio valleys, then disappearing gradually as we approach the Alleghenies and, farther south, the Atlantic coast, also spreading southward from Mexico to Honduras, and changing and vanishing in South America. Unquestionably of very great antiquity, this art, developed in the neolithic period of culture, reached to the age of metals, and had already begun to decline at the time of the Spanish conquest. How this remarkable development came to exist amid its different environments we cannot yet fully understand; but the question arises: Was it of autochthonous origin and due to a particular period in man's development, or was it a previously existing phase

modified by new environment? For the present this question should be held in abeyance. To declare that the resemblance of this art to both Asiatic and Egyptian art is simply a proof of the psychical unity of man is assuming too much and is cutting off all further consideration of the subject.

The active field and museum archæologist who knows and maintains the association of specimens as found, and who arranges them in their geographical sequence, becomes intimately in touch with man's work under different phases of existence. Fully realizing that the natural working of the human mind under similar conditions will to a certain extent give uniform results, he has before him so many instances of the transmission of arts, symbolic expressions, customs, beliefs, myths and languages that he is forced to consider the lines of contact and migration of peoples as well as their psychical resemblances.

It must be admitted that there are important considerations, both physical and mental, that seem to prove a close affinity between the brown type of eastern Asia and the ancient Mexicans. Admitting this affinity, the question arises: Could there have been a migration eastward across the Pacific in neolithic times, or should we look for this brown type as originating in the Eurafric region and passing on to Asia from America? This latter theory cannot be considered as a baseless suggestion when the views of several distinguished anthropologists are given the consideration which is due to them. On the other hand, the theory of an early migration from Asia to America may also be applied to neolithic time.

However this may have been, what interests us more at this time, and in this part of the country, is the so-called 'Mound Builder' of the Ohio Valley. Let us first clear away the mist which has so long prevented an understanding of this subject by discarding the term 'Mound Builder.' Many peoples in America, as well as on other continents, have built mounds over their dead, to mark important sites and great events. It is thus evident that a term so generally applied is of no value as a scientific designation. In North America the term has been applied even to refuse piles: the kitchen-middens or shell-heaps which are so numerous along our coasts and rivers have been classed as the work of the 'Mound Builder.' Many of these shell-heaps are of great antiquity, and we know that they are formed of the refuse gathered on the sites of the early peoples. From the time of these very early deposits to the present such refuse piles have been made, and many of the sites were reoccupied, sometimes even by a different people. These shell-heaps, therefore, cannot be regarded as the work of one people. The same may be said in regard to the mounds of earth and of stone so widely distributed over the country. Many of these are of great antiquity, while others were made within the historic period and even during the first half of the present century. Some mounds cover large collections of human bones; others are monuments over the graves of noted chiefs; others are in the form of effigies of animals and of man; and, in the South, mounds were in use in early historic times as the sites of ceremonial or other important buildings. Thus it will be seen that the earth-mounds, like the shell-mounds, were made by many peoples and at various times.

There are, however, many groups of earthworks which, although usually classed as mounds, are of an entirely different order of structure and must be considered by themselves. To this class belong the great embankments, often in the form of squares, octagons, ovals and circles, and the fortifications and singular structures on hills and plateaus, which are in marked contrast to

the ordinary conical mounds. Such are the Newark, Liberty, Highbank and Marietta groups of earthworks, the Turner group, the Clark or Hopewell group, and many others in Ohio and in the regions generally south and west of these great central settlements; also the Cahokia Mound opposite St. Louis, the Serpent Mound of Adams County, the great embankments known as Fort Ancient which you are to visit within a few days, the truly wonderful work of stone known as Fort Hill in Highland County, and the strange and puzzling walls of stone and cinder near Foster's Station.

So far as these older earthworks have been carefully investigated, they have proved to be of very considerable antiquity. This is shown by the formation of a foot or more of vegetable humus upon their steep sides, by the forest growth upon them which is often of primeval character, and by the probability that many of these works, covering hundreds of acres, were planned and built upon the river terraces before the growth of the virgin forest.

If all mounds of shell, earth or stone, fortifications on hills, or places of religious and ceremonial rites, are classed irrespective of their structure, contents, or time of formation, as the work of one people, and that people is designated 'the American Indian' or the 'American Race,' and considered to be the only people ever inhabiting America, North and South, we are simply repeating what was done by Morton in relation to the crania of America—not giving fair consideration to differences while overestimating resemblances. The effort to affirm that all the various peoples of America are of one race has this very year come up anew in the proposition to provide 'a name which shall be brief and expressive' and at the same time shall fasten upon us the theory of unity—notwithstanding the facts show diversity—of race.

Let us now return to the builders of the older earthworks, and consider the possibility of their having been an offshoot of the ancient Mexicans. Of the crania from the most ancient earthworks we as yet know so little that we can only say that their affinities are with the Toltecan type; but of the character of the art, and particularly the symbolism expressing the religious thought of the people, we can find the meaning only by turning to ancient Mexico. What Northern or Eastern Indian ever made or can understand the meaning of such sculptures or such incised designs as have been found in several of the ancient ceremonial mounds connected with the great earthworks? What Indian tribe has ever made similar carved designs on human and other bones, or such singular figures, cut out of copper and mica, as were found in the Turner and Hopewell groups? Or such symbolic animal forms, elaborately carved in stone, and such perfect terra cotta figures of men and women as were found on the sacrificial altars of the Turner group? What meaning can be given to the Cincinnati Tablet, or to the designs on copper plates and shell discs from some of the Southern and Western burial and ceremonial mounds? I think we shall search in vain for the meaning of these many objects in the North or East, or for much that resembles them in the burial places of those regions. On the other hand, most of these become intelligible when we compare the designs and symbols with those of the ancient Mexican and Central American peoples. The Cincinnati Tablet, which has been under discussion for over half a century can be interpreted and its dual serpent characters understood by comparing it with the great double image known in Mexico as the Goddess of Death and the God of War. The elaborately complicated designs on copper plates, on shell discs, on human bones and on the wing bones of the eagle

can in many instances be interpreted by comparison with Mexican carvings and with Mexican modes of symbolic expression of sacred objects and religious ideas. The symbolic animals carved on bone or in stone and the perfection of the terra cotta figures point to the same source for the origin of the art.

In connection with the art of the builders let us consider the earth structures themselves. The great mound at Cahokia, with its several platforms, is only a reduction of its prototype at Cholula. The fortified hills have their counterparts in Mexico. The serpent effigy is the symbolic serpent of Mexico and Central America. The practice of cremation and the existence of altars for ceremonial sacrifices strongly suggest ancient Mexican rites. We must also recall that we have a connecting link in the ancient pueblos of our own Southwest, and that there is some evidence that in our Southern States, in comparatively recent times, there were a few remnants of this old people. It seems to me, therefore, that we must regard the culture of the builders of the ancient earthworks as one and the same with that of ancient Mexico, although modified by environment.

Our Northern and Eastern tribes came in contact with this people when they pushed their way southward and westward, and many arts and customs were doubtless adopted by the invaders, as shown by customs still lingering among some of our Indian tribes. It is this absorption and admixture of the peoples that has in the course of thousands of years brought all our American peoples into a certain conformity. This does not, however, prove a unity of race.

It is convenient to group the living tribes by their languages. The existence of more than a hundred and fifty different languages in America, however, does not prove a common origin, but rather a diversity of origin as well as a great antiquity of man in America.

That man was on the American continent in quaternary times, and possibly still earlier, seems to me as certain as that he was on the Old World during the same period. The Calaveras skull, that bone of contention, is not the only evidence of his early occupation of the Pacific coast. On the Atlantic side the recent extensive explorations of the glacial and immediately following deposits at Trenton are confirmatory of the occupation of the Delaware Valley during the closing centuries of the glacial period and possibly also of the interglacial time. The discoveries in Ohio, in Florida and in various parts of Central and South America all go to prove man's antiquity in America. Admitting the great antiquity of one or more of the early groups of man on the continent, and that he spread widely over it while in the palæolithic and early neolithic stages of culture, I cannot see any reason for doubting that there were also later accessions during neolithic times and even when social institutions were well advanced. While these culture epochs mark certain phases in the development of a people, they cannot be considered as marking special periods of time. In America we certainly do not find that correlation with the Old World periods which we are so wont to take for granted.

We have now reached the epoch of careful and thorough exploration and of conscientious arrangement of collections in our scientific museums. It is no longer considered sacreligious to exhibit skulls, skeletons and mummies in connection with the works of the same peoples. Museums devoted primarily to the education of the public in the æsthetic arts are clearing their cases of heterogeneous collections of ethnological and archæological objects. Museums of natural history are being arranged to show the history and distribution of animal

and vegetable life and the structure of the earth itself. Anthropological museums should be similarly arranged and, with certain gaps, which every curator hopes to fill, they should show the life and history of man. To this end the conscientious curator will avoid the expression of special theories and will endeavor to present the true status of each tribe or group of man in the past and in the present, so far as the material at his command permits. A strictly geographical arrangement is, therefore, the primary principle which should govern the exhibition of anthropological collections. A special exhibit may be made in order to illustrate certain methods by which man in different regions has attained similar results, either by contact or by natural means. Another exhibit may be for the purpose of showing the distribution of corresponding implements over different geographical areas. These and similar special exhibits are instructive and under proper restrictions should be made, but unless the design of each exhibit is clearly explained, the average visitor to a museum will be confused and misled, for such objects so grouped convey a different impression than when exhibited with their associated objects in proper geographical sequence.

The anthropology of America is now being investigated and the results are being made known through museums and publications as never before.

The thoroughly equipped Jesup North Pacific Expedition, with well-trained anthropologists in charge, was organized for the purpose of obtaining material both ethnological and archæological for a comparative study of the peoples of the northern parts of America and Asia. Although only in the third year of its active field work, it has already furnished most important results and provided a mass of invaluable authentic material.

The Hyde Expedition planned for long-continued research in the archæology and ethnology of the Southwest, a successor in regard to its objects to the important Hemenway Expedition, is annually adding chapters to the story of the peoples of the ancient pueblos.

The results of the extensive explorations by Moore of the mounds of the southern Atlantic coast are being published in a series of important monographs.

The Pepper-Hurst Expedition to the Florida Keys has given information of remarkable interest and importance from a rich archæological field before unknown.

The United States government, through the Bureau of Ethnology of the Smithsonian Institution, has given official and liberal support to archæological and ethnological investigations in America.

The constantly increasing patronage, by wealthy men and women, of archæological research at home, as well as in foreign lands, is most encouraging.

The explorations in Mexico and in Central and South America, the publication in fac-simile of the ancient Mexican and Maya codices, the reproduction by casts of the important American sculptures and hieroglyphic tablets, all have been made possible by earnest students and generous patrons of American research.

The numerous expeditions, explorations and publications of the Smithsonian Institution and of the museums of Washington, Chicago, Philadelphia, New York and Cambridge are providing the student of to-day with a vast amount of authentic material for research in American and comparative anthropology.

The archæological Institute of America, the American Folk-Lore Society and the archæological and anthropological societies and clubs, in active operation in various parts of the country, together with the several journals devoted to different branches

of anthropology, give evidence of widespread interest.

Universities are establishing special courses in anthropology, and teachers and investigators are being trained. Officers of anthropological museums are preparing men to be field workers and museum assistants. The public need no longer be deceived by accounts of giants and other wonderful discoveries. The wares of the mercenary collector are now at a discount since unauthentic material is worthless.

Anthropology is now a well-established science; and with all this wealth of materials and opportunities, there can be no doubt that in time the anthropologists will be able to solve that problem, which for the past half century has been discussed in this Association—the problem of the unity or diversity of prehistoric man in America.

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*THE FIELD OF EXPERIMENTAL RESEARCH.**

PHYSICAL research by experimental methods is both a broadening and a narrowing field. There are many gaps yet to be filled, data to be accumulated, measurements to be made with great precision, but the limits within which we must work are becoming, at the same time, more and more defined.

The upper ranges of velocities, temperatures and pressures, which manifest themselves in the study of the stellar universe, are forever beyond the range of experiment. But while the astronomer must wait for opportunities to observe, the experimenter can control his conditions and employ his methods and his apparatus at once to the question in hand. Still this work must be done within a certain range or must be limited to conditions more or less easy to recognize. In spite of this fact, however, the progress made during the past century is not likely to cease or abate in the next, and the ever-increasing number of workers bodes well for the future enrichment of our science.

Whatever may be our ideas of fundamental entities, as expressed in various theories; whether, as an example, we regard the ether as like an infinitely mobile fluid, or as an incompressible solid, or as a jelly; or whether we incline to think that being an electromagnetic medium, it may be without mechanical properties, which properties depend in some way upon the electromagnetic nature of the ether, we cannot reach sure ground without the experimental test.

The development in the field of research by experiment is like the opening of a mine, which, as it deepens and widens, continually yields new treasure, but with increased difficulty, except when a rich vein is struck and worked for a time. In general, however, as the work progresses there will be needed closer application and more refined methods. We may, indeed, find our limit of depth in the mine of experiment in inordinate cost, in temperatures too high, or in pressures beyond the limits of our skill to control.

It is but a few months since Professor Dewar, by the evaporation of liquid hydrogen in a vacuum, closely approached, if he has not reached, our lower limit of possible temperature. Investigations of the effects of low temperature upon the properties of bodies must, from the present outlook, be forever limited to about 20° C. above absolute zero, unless a lighter gas than hydrogen be discovered upon the earth, the actual existence of which it is, of course, impossible to conjecture. Before the actual experimental demonstration of this limit the limit itself was known to theory, at least approximately, but the spur of the experi-

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menter is the overcoming of difficulties and the possibility of new discoveries which come as surprises. In the case in question a liquid of extremely low density, only one-fourteenth that of liquid nitrogen, was produced, while still defined by clear and well-marked refracting surfaces.

When we turn to the consideration of the field for research work at high temperatures we are not confronted by the fact of a physical limit existing which may be approached but never reached. We can imagine no limit to possible increase of temperature, such as is the absolute zero a limit of decrease. While we may actually employ in electric furnaces temperatures which, according to Moissan, have a lower limit of 3,500° C., we can realize the possibility of temperatures existing in the stars measured by tens of thousands or hundreds of thousands of degrees of our temperature scale.

The moderate increase of working temperature given by the electric furnace enabled Moissan and others to reap a rich harvest of experimental results, and the natural inference is that much more might be expected from further extensions of the limits. These limits are, however, already set for us by the vaporization of all known substances. Our furnace itself keeps down the temperature by melting and volatilizing. We may indefinitely increase the energy in an electric arc and thus add to the heat evolved, but the addition only goes to vaporize more material. The limit of work then seems to be readily reached in the electric furnace, no materials for lining being available, not subject either to fusion or vaporization, thus using up the energy which would otherwise go to increase the temperature.

A suggestion as to a possible extension of temperature range may be made here. It may be requisite to work with closed receptacles under pressure, and to discharge through them electric currents of so great energy-value as to attain almost instantaneously the highest temperatures, to be maintained for only a very short time. We may imagine a huge condenser charged to a potential of, say, 10,000 volts as discharged through a limited body of gas contained in a small space within a strong steel tube which has a lining of refractory non-conductor. The energy may thus possibly be delivered so suddenly to a very limited body of material as to result in a momentary elevation of temperature passing all present known limits and capable of effecting profound changes in molecular constitution. We need all possible extension of the limits of research in this direction in order to discover some clue to the relations which the chemical elements bear to each other. The limit of possible strength of the containing receptacle, or some unforeseen factor, would probably set the new bounds. The point to be here enforced, however, is that far beyond any increase of working range in temperature, obtained in any way, there must still exist a further range unattainable by our best efforts and possibly forever outside of the field of experimental research. Our knowledge of this higher range can alone be derived from a study of the actions going on in the stars and nebulæ.

As with the temperature range so it is with the pressure range. We may easily work under conditions which involve no pressure, but when we attempt to conduct our inquiries with increase of pressure we soon find a limit to the tenacity of our strongest vessels or to our ability to produce and maintain extreme pressures. We may work, not easily it is true, with pressures up to a few tons to the square inch, but this is as nothing compared to the conditions which we know must exist within the larger celestial bodies, without reference to their condition, solid, liquid or gaseous. Can we ever hope to experimentally repro-

duce the condition of a mass of gas so compressed that in spite of a very high temperature its volume is less than that of the same mass cooled to solidification? Yet this extreme of condition must be the normal state within the bodies of many of the stars.

It has been aptly said that many, and perhaps most, of the important discoveries have been made with comparatively simple and crude apparatus. While this may be true, yet it is probably true also that future advance work is likely to require more and more refined means and greater nicety of construction and adjustment of apparatus. The expense or cost, if not the difficulty of the work, may become so great as to effectually bar further progress in some fields. When instruments require to be adjusted or constructed, to such refined limits as a fraction of a wave-length of light, but few can be found to undertake the work. The interferometer and echelon spectroscope of Michelson involve such minute adjustments that a wave-length of light is relatively thereto a large measure. It is well known that this comparative coarseness of light waves imposes a limit to the powers of optical instruments, as the microscope and telescope, such that no perfection of proportion, construction and correction of the lenses can remove.

In most fields of research, however, progress in the future will depend in an increasing degree upon the possession, by the investigator, of an appreciation of small details and magnitudes, together with a refined skill in manipulation or construction of apparatus. He must be ready to guide the trained mechanic and be able himself to administer those finishing touches which often mark the difference between success and failure. There must be in his mental equipment that clear comprehension of the proper adjustment of means to ends which is of such great value in work in new fields. He must also learn to render available to science the resources of the larger workshops and industrial establishments.

The application of physical principles upon a large scale in such works has frequently, in recent years, resulted in great gains to science itself. The resources of the physical laboratory are often relatively small and meagre compared with those of the factory. Experimental work in certain lines is now frequently carried on upon a scale so great and under such varied conditions as would be almost impossible outside of a large works.

In no field has this been more true than in that of electricity during the past few years. We need only instance the progress in alternating currents and in relation to the magnetic properties of iron. In large scale operations effects which would be missed or remain masked in work undertaken upon a more restricted scale receive emphasis sufficient to cause them to command attention. The obstacle of increasing costliness of equipment, which in some fields might act as a bar to further progress, can only be overcome by more liberal endowments of laboratories engaged in advance work. Even those in the community who can only understand the value of scientific work when it has been put to practical use may find in the history of past progress that many discoveries in pure science which had not, when made, any apparent commercial importance or value have in the end resulted in great practical revolutions.

Could Volta, when he discovered the pile one hundred years ago, have had any idea of its importance in practical work? Or, did Davy or his contemporaries at the time of his experiments with the arc of flame between the charcoal terminals of his large battery have any suspicion that in less than one hundred years the electric arc would grow to such importance that more

than 100,000 arc lamps would become a single year's production in this country alone. Faraday, when he made his researches npon the induction of electric currents from magnetism, could not have had any idea of the enormous practical work in which the principles he dealt with as facts of pure science would find embodiment. When he wound upon the closed iron ring the two coils of wire which enabled him to discover the facts of mutual induction he had begun, without any suspicion of the fact, the experimental work which gave to science and to practice the modern transformer, now built of capacities ranging up to 2,500 H. P. each, and for potentials of 40,000 to 60,000 volts.

These examples, and many others which might be given, should convince even the most arrogantly practical man of the high value of scientific research, not alone as adding to the sum-total of knowledge and for the admirable training it gives, but because it cannot fail to have an ultimate practical effect. Discoveries which at first seem to have no useful nor practical outcome are often the very ones which underlie development of the greatest importance in the arts and industries.

The work of Hertz upon electric waves was to the physicist a grand experimental demonstration, tending to prove the truth of the electromagnetic theory of light, and subsequent progress was profoundly influenced by it, though no practical use followed at once. The physicist to-day may see in the wireless telegraph only an extension of Hertz's original work, for he need not consider the commercial or economic outcome. He may, however, recognize the fact that in the wireless telegraph, as developed by Marconi, practice calls for a broader theoretical view. Certain elements of construction and adjustment of apparatus, at first used and regarded as essential from a theoretical standpoint, have already been laid aside. The radiator, with its large polished brass spheres and special spark gap, has been found of no more effect than the simple pair of small balls ordinarily constituting the terminals for high potential discharges. It has been found that the transmitting and receiving apparatus do not require to be attuned, and that the receiving coherer is not the true recipient of the electric wave or disturbance in the ether.

These later developments are, in fact, departures, more or less wide, from the principles underlying the Hertz demonstration. A vertical wire is charged to a high potential and discharges to earth over a spark gap. During the discharge the wire becomes a radiator of electromagnetic pulses or waves, regardless of the spark radiation. The receiving vertical wire is likewise alone relied upon to absorb the energy. Being in the path of the electromagnetic wave conveyed in the ether from the transmitting wire, it becomes the seat of electromotive forces which break down the coherer. This, in substance, may be considered as a series of small or microscopic spark gaps which can be crossed by the comparatively low potentials developed in the receiving wire. We are thus taught to recognize the fact that the refinements in methods and apparatus needed for a delicate physical demonstration as of the Hertz waves in this instance may often be laid aside in practical application, where the end to be achieved is different. The sudden discharge of the Marconi transmitting wire may possibly give rise to a series of oscillations or high-frequency alternating waves in the wire, but since the first half of the first wave at each discharge will have the greatest amplitude it is doubtful if those which follow in the short train have any decided effect upon the receiver. According to this view the fact of the discharge being oscillatory may, indeed, have no essential relation to the work done, but

may be an unavoidable incident of the very sudden discharge which itself would set up a single pulse in the ether sufficiently intense for the work even if unaccompanied by lower amplitude oscillations following the first discharge pulse.

Before leaving the consideration of this most fruitful field of experimental research opened by Hertz, it may be stated that the one gap in the work yet to be filled is the actual production of electric waves of a wave-length corresponding to those of the spectrum. If this could be done by some direct method, no matter how feeble the effect obtained, the experimental demonstrations of the electric nature of radiant heat and light would be fitly completed. Several years ago it occurred to me that it might be possible to devise a method for accomplishing the end in view, and so close the existing gap. Many years ago an observation on sound echoes showed clearly the production of high-pitch sounds from single pulses, or lower-pitch waves. A bridge over a mile in length was boarded at the sides, and vertical slats regularly and closely placed along its side formed, for a sound wave incident thereon, a series of reflecting edges or narrow vertical surfaces, a kind of coarse grating. It was found that a loud sound or pulse, such as that of a gun-shot, emanating from a point near one end of the bridge and two to three hundred feet in a line from the structure, was followed by an echo which was in reality a high-pitch musical tone. The pitch of this tone corresponded to the spacing of the slats in the bridge considered as a reflecting grating for sound.

Following this principle, it seems possible that a very sudden pulse in the ether or electromagnetic wave, incident at an angle upon a reflecting grating having from 20,000 to 40,000 ruled lines to the inch, if the plane of incidents were at right angles with the rulings, might be thrown into ripples of the wave-length of light and yield a feeble luminosity. If the color then varied with the angle of incidence chosen and with the angle through which the reflection passed to the eye the experiment would be conclusive.

Despite the diligent studies which had been made in the invisible rays of the spectrum, both the ultrared and ultraviolet, a work far from completion as yet, the peculiar invisible radiation of the Crookes tube remained unknown until the work of Lenard and Röntgen brought it to the knowledge of the world. The cathode discharge, studied so effectively by Hittorf and Crookes, and by the latter called 'radiant matter,' was but a part of the whole truth in relation to the radiation in high vacua. It is needless to recount the steps in the discovery of Röntgen rays. We now know that these rays come from the impingement of the 'radiant matter' or cathode rays. We know, also, that the higher the vacuum, and, therefore, the higher the electric potential needed to effect the discharge, the more penetrating or the less easily absorbed is the resulting radiation. Rays have been produced which in part pass through cast iron nearly an inch thick. The iron acting as a filter absorbs all rays of less penetrating power. A question may here be put, which it will be for future experiment to answer: Can we, by increasing the degree of vacuum in a Crookes tube by the employment of enormous potentials for forcing a discharge through the higher vacuum, produce rays of greater and greater penetrating power? What, in fact, may be the limit, or is there any limit, to the diminution of wave-length in the ether, assuming for the moment that this invisible radiation is somewhat of the same nature as light, but of higher pitch, though it may be unlike light in not representing regular wave trains.

Röntgen radiation, while spoken of as

invisible, is in reality easily visible if of great intensity. The parts of the retina which respond and so give the sensation of luminosity are apparently those around the eye and not directly opposite to the iris opening. Those parts of the retina sensitive to the rays are characterized by the preponderance of 'rods,' giving the simple sensation of illumination, apparently white in the case in question. The 'cones,' or those portions of the retinal membrane whose function is believed to be the recognition of color or differences of wavelength, appear not to be excited by the Röntgen radiation, or only very feebly. If this be true it would account for the less intensity of the luminous effect upon those portions of the retina near the optic axis of the eye. All this favors the view that the Röntgen radiation is without sustained pitch or wave trains, and resembles more a sharp noise or crash in sound.

For pressing experimental work in the highest vacua to its limit, as above suggested, we already have means at command for the production of the most complete exhaustions, requiring extremely high potentials to pass an electric discharge. We have, also, in well-known forms of high-frequency apparatus the means for producing electromotive forces limited only by our means for insulation. A recent apparatus devised by me and called a dynamostatic machine gives equal capability of producing high potentials of definite polarity, positive and negative. It should not be long, therefore, before work is undertaken in this suggested direction of pressing this matter of rays of high penetrating power much farther than has been done. The question arises whether any such rays can exist which are not appreciably absorbed in passing through dense substances. They would probably not affect a photographic plate nor a fluorescent screen. If they lost also the property of ionizing a gas and causing electric convection we might not even be able to discover them. That some influence or action in the ether does actually penetrate the dense masses in space is evidenced by gravitation, the mystery of mysteries. We are, however, not justified in going beyond the proved facts which can only be the result of experimental work and close observation. All else is speculation. The energy source of the Becquerel rays is another mystery apparently far from being cleared up, and if it be true, as recently announced, that a substance named radium has in reality nine hundred times the power of emitting these rays than is possessed by uranium and thorium, and that the radiation is able to cause visible fluorescence of barium platinocyanide, the mystery but deepens and makes us again think of the possible existence of obscure rays only absorbed and converted by a few special substances.

The diffusion which takes place when Röntgen rays pass through various media is another phenomenon which needs more attention from investigators. This effect seems to be produced by all substances in a greater or less degree. It, however, appears to be nearly absent in the case of those substances which give out light or fluoresce under the rays, as barium platinocyanide and calcium tungstate. It will be important to determine definitely whether the rays diffused by different substances are lowered in pitch or penetrating power as compared with the rays exciting the diffusion; whether, in other words, the rays from a tube with quite high vacuum excite similar rays by diffusion, or rays more absorbable; and if a lowering takes place whether it occurs in like manner and degree for all diffusing media.

The phenomenon may be akin to fluorescence, as when quinia sulphate converts the invisible ultraviolet rays of the spectrum into lower rays or visible light. This

action may be at its extreme when barium platinocyanide, excited by Röntgen rays, so lowers the pitch as to produce rays within the visible spectrum, for this compound gives very little or no Röntgen-ray diffusion. Are there substances which under Röntgen rays fluoresce with invisible rays of the order of the ultraviolet of the spectrum? If, as is the case with solid paraffine, the irradiated substance gives rise to considerable diffusion it can, as I have noted, produce a secondary diffusion in other masses of the same substance, or of other substances, as indicated by feeble fluorescence of the sensitive barium salt, thoroughly screened from the direct source of rays and from the first or primary diffusion. It is probable that Tertiary diffusion could be found if we possessed a far more powerful or continuous source of the rays for exciting the initial diffusion. The ray emission, even in the most powerfully excited tube, is probably so intermittent that the active period is but a fraction of the total time. It may easily be that the limit of intensity of Röntgen-ray emission has not yet been reached, especially when artificially cooled anti-cathode plates are available.

There is much room for experimental work in this fascinating field. We need for it the means for the production either of a continuous electric discharge at from 60,000 to 100,000 volts or a high-frequency apparatus capable of giving an unbroken wave train; that is, a succession of high period waves of current without breaks or intermissions.

The ordinary high-frequency apparatus for obtaining discharges of high potential from alternating currents gives only a rapid succession of discharges each consisting of a few rapidly dampened oscillations. These discharges occupy but a small fraction of the total time. This is very different from a continuous sustained wave train, with the successive waves of equal amplitude following each other without break. Such sustained waves will, doubtless, be of use in research, especially in vacuum-tube work, and they would, of course, convey much more energy than the usual brokon or interrupted discharge known as a high-frequency discharge.

Some six or seven years ago I endeavored, while working upon the subject of high frequency, to fill the gap. The result was an apparatus which, with its modifications, deserves more study and experiment than I have been able to give to it. A brief description may not be out of place. A large inductance coil with a heavy iron wire bundle for a core, a coil of relatively few turns with no iron core, and a condenser of variable capacity, were connected in series across the mains of a 500-volt electric circuit. The smaller coreless coil and the condenser were arranged to be shunted by an adjustable spark gap with polished ball terminals. By simply closing for a moment the spark gap so as to form a low resistance shunt around the condenser and the small coil, and afterward slowly separating the balls, the local circuit of the condenser, small coreless coil and shunting gap become the seat of sustained oscillations, the frequency of which depends upon the relation of inductance and capacity in the local circuit. The energy supplied is that of a continuous current through the large inductance coil with the heavy core. The action of the apparatus is easily comprehended by a little study. The oscillating current in the local circuit may be made to induce much higher potentials in a secondary circuit inductively related thereto. In this case the turns of the secondary in relation to the primary are, as usual, such as to step-up the potential. In other words the potential developed in the secondary is determined by the transforming ratio.

We thus have a high-frequency apparatus

in which the waves are sustained in an unbroken series, and we employ as the source of energy a continuous current circuit. It shows that we may continuously supply energy to an oscillating system and so keep up the amplitude of electric oscillations, the frequency of which is that due to the capacity and inductance of the part of the circuit in which oscillations are set up.

While, in the forms of high-frequency apparatus alluded to, we may obtain almost any differences of electric potential up to millions of volts, assuming the apparatus large enough for the work, we do not get a sustained separation of positive and negative charges, as in the static machine, or in a less complete degree with the inductive coil. Professor Trowbridge, of Harvard, has, however, made use of large Planté rheostatic machines, the condenser plates of which are charged in parallel from 10,000 small storage cells connected in series. The discharge of the condenser plates is effected after they are connected in series by a suitable connection changing frame moved for the purpose. Very high potential discharges are thus obtained and the polarity is always definite. It is manifest that the size of the apparatus and the perfection of its insulation determine the possible performance. The objection to such an apparatus for experimental research or demonstration is the large number of cells required and the complicated arrrangements of circuits for charging them. I have, however, recently succeeded in removing all necessity for the presence of charging cells, and have produced what may be termed a dynamostatic machine which is worked by power or by current from a lighting circuit, either continuous or alternating, and may replace a static machine. It is, of course, not dependent upon the weather. I trust it may be of sufficient interest to merit the following brief description: A small electric motor has in addition to its commutator a pair of rings connected to its armature winding for obtaining alternating currents. The shaft of the motor drives synchronously a revolving frame bearing connections which, as in the Planté rheostatic machine, connect a series of condenser plates alternately in parallel for charging and in series for discharging at high potential. A small oil-immersed step-up transformer has its primary connected to the brushes bearing upon the two alternating current rings of the motor, and its secondary, giving say 20,000 volts, is periodically connected to the condenser plates while in parallel, by means of the revolving connection frame. The adjustment is such that only the tops of the alternating waves or their maxima are used to charge the condenser plates, while, also, those halves of the waves which are of the same polarity are alone used, the others being discarded or left on open circuit. The apparatus may be driven by power, in which case the electric motor becomes a dynamo, exciting its own field and supplying alternating current to the primary of the step-up transformer, or suitable alternating currents may drive it as a synchronous motor. Such a machine, run by continuous currents and having only eleven plates, gives sparks between its terminals over twelve inches long in rapid succession. It can be built cheaply, and is a highly instructive machine from the transformations it illustrates.

The machine is also arranged by the addition of a simple attachment, so that it may be used to charge insulated bodies, or to charge Leyden-jar condensers or the like, replacing the ordinary static machines. It might, in fact, be used to charge a second range of condenser plates in another rheostatic machine to a potential of 100,000 volts, for example. These, after coupling in series or cascade, might be made to yield potentials beyond any thus far obtained.

The interest in such experimental ap-

paratus and the results obtained come largely from the apparent ability to secure a representation of the effects of lightning discharges upon a moderate scale, and the possibility of studying the action of air and other gases, as well as liquids and solids, at varying temperatures and pressures under high electric stresses. Broadly considered, however, the similarity of the effects to those produced in a thunder cloud is more apparent than real. The globules of of water constituting the electrified cloud do not possess charges of millions of volts potential, the effects of which are seen in the stroke of lightning. The individual globules may possess only a moderate charge. When, however, they are massed together in a large extent of cloud the virtual potential of the cloud as a whole, with respect to the earth, may be enormous, though no part of the cloud possesses it. The cloud mass not being a conductor, its charge cannot reside upon its outer surface or upon its lower surface nearest the earth, as with a large insulated conductor. The charge, in fact, exists throughout the mass, each globule of water suspended in the air having its small effect upon the total result.

When the cloud discharges, the main spark branches within and through the cloud mass in many directions. The discharge can at best be only a very partial one, from the nature of the case. These are conditions which are certainly not represented in our experimental production of high-potential phenomenon, except perhaps upon a very small scale in the electrified steam from Armstrong's hydroelectric machine, a type of apparatus now almost obsolete. Yet if we wish to reproduce, as nearly as possible upon a small scale, the conditions of the thunder cloud, we shall be compelled to again resort to it. In volcanic eruptions similar actions doubtless occur and give rise to the thunder clouds which often surround the gases sent out from the crater.

Considering, then, that the conditions in the thunder cloud are so different from those in our experiments with high potentials, we can easily understand that the study of lightning phenomena may present problems difficult to solve. Two forms at least of lightning discharge are quite unknown in the laboratory—namely, globular lightning and bead lightning, the latter the more rare of the two. Personally I cannot doubt the existence of both of these rare forms of electric discharge, having received detailed accounts from eye witnesses. On one occasion, while observing a thunder storm, I narrowly missed seeing the phenomenon of globular lightning, though a friend who was present, looking in the opposite direction, saw it. The explosion, however, was heard, and it consisted of a single detonation like the firing of a cannon. According to the testimony of an intelligent eye-witness, who described the rare phenomenon of bead lightning within an hour after it had been seen, it is a very beautiful luminous appearance like a string of beads hung in a cloud, the beads being somewhat elliptical and the ends of their axes in the line of their discharge being colored red and purple respectively. This peculiar appearance, not at any time dazzlingly bright, persisted for a few seconds while fading gradually.

Again, our knowledge of the aurora is not as yet much more definite or precise than it is in regard to the obscure forms of lightning alluded to above. Whether these phenomena will ever be brought within the field of research by experimental methods is an open question.

The endeavor in the foregoing rather disconnected statements has been to indicate directions in which the field of experiment may be extended and to emphasize the fact that research must be carried on by extension of limits, necessitating more liberal en-

dowment of research laboratories. I have tried to make it clear that the physicist must avail himself of the powers and energies set in play in the larger industrial enterprises, and finally that the field of possible exploration in physics by experimental methods has its natural boundaries, outside of which our advances in knowledge must be derived from a study of celestial bodies.

The riddle of gravitation is yet to be solved. This all-permeating force must be connected with other forcec and other properties of matter. It will be a delicate task, indeed, for the total attraction between very large masses closely adjacent, aside from the earth's attraction, is very small.

Scientific facts are of little value in themselves. Their significance is their bearing upon other facts, enabling us to generalize and so to discover principles, just as the accurate measurement of the position of a star may be without value in itself, but in relation to other similar measurements of other stars may become the means of discovering their proper motions. We refine our instruments ; we render more trustworthy our means of observation ; we extend our range of experimental inquiry, and thus lay the foundation for the future work, with the full knowledge that, although our researches cannot extend beyond certain limits, the field itself is, even within those limits, inexhaustible.

Elihu Thomson.

PHOSPHORESCENT SUBSTANCES AT LIQUID-AIR TEMPERATURES.

A recent number of the *Philosophical Magazine** contains a paper 'On Phosphorescence,' by Herbert Jackson, which was delivered before the meeting of the British Association at Bristol, September 12, 1898, a portion of the paper being devoted to a review of the results obtained in researches relating to phosphorescent phenomena. It is evident from the paper that considerable investigation has been undertaken to ascertain the effects of high temperatures on phosphorescent substances, but that comparatively little has been done towards learning the behavior of the latter at very low temperatures, such as are obtained by the use of liquefied air. It is stated, however, in the paper referred to, that, "Professor Dewar has shown that great reduction of the temperature will cause phosphorescence to linger for a considerable time in many substances which had hitherto been considered as practically non-phosphorescent." This in particular refers to the phosphorescence produced in certain substances when exposed to light while at a temperature near that of liquefied air. Ivory, paper, and various other materials show phosphorescence under such conditions, but little or none at normal temperatures (20° C.).

Professor Dewar has found also that when a phosphorescent substance is excited by light at a normal temperature and then immersed in liquefied air the phosphorescent discharge is practically suspended, and continues so while the substance remains at the low temperature. August and Louis Lumiere have recently published a note in the *Comptes rendus*, CXXVIII., No. 9, 1899, p. 549, 'Influence des températures très basses sur la phosphorescence,' to which reference will be made presently.

The results obtained in some experiments made by the writer on the effect of liquid-air temperatures on phosphorescent substances are given below. These experiments were already completed when it was learned that the above-mentioned note in the *Comptes rendus* had been published. They were as follows :

Balmain's luminous paint, which is strongly phosphorescent at normal temperatures, was subjected to a very low temperature by the use of liquefied air, boiling

* *Phil. Mag.*, Lon. 46, 281, p. 402, Sept., 1898.

under atmospheric pressure. The sun and the electric arc were both used to excite phosphorescence in this substance. The temperature of the liquefied air employed, from experiments made with a platinum resistance thermometer, was determined to be approximately −188° C. It varied several degrees during the experiments, on account of changes in the composition of the liquefied air, due to ebullition.

Balmain's paint is a polysulphide of calcium mixed with varnish. The former is prepared by a secret process, but probably produced by mixing the powdered shells of certain shellfish with sulphur, and calcining these together at a high temperature in a closed crucible.

A number of experiments were performed with Balmain's paint at about 20 C. in order to ascertain the properties of this particular substance at ordinary temperatures.

Test cards of the phosphorescent material were prepared for the experiments in the following manner:

A sheet of cardboard was covered with dead black paper and a portion of it coated as evenly as possible with the luminous paint; it was then cut into cards, each having a surface approximately 4 x 5 centimeters coated with paint. Test plates of thin sheet iron were also coated with the same substance.

The preliminary experiments, at normal temperatures (20° C.), showed: (1) that Balmain's paint, exposed for a few seconds to the sun or the electric arc, gave bright violet phosphorescence when removed immediately away from strong light, and that after being in the dark for three hours its luminosity was so faint as to be hardly visible; (2) that a very slight elevation of temperature, a few degrees, caused a perceptible brightening of the phosphorescent surface, and that when the temperature of the substance was lowered, its luminosity was lessened in a corresponding manner; (3) that the brightening of the phosphorescent surface caused by the application of heat was merely a rapid discharge of the phosphorescent energy; (4) that a test card of luminous paint exposed to sunlight and then placed in darkness for three weeks showed phosphorescence when heated to about 300 degrees C.; (5) that the part of the solar spectrum producing phosphorescence in the substance employed was practically entirely that towards the violet end; (6) that the infra-red rays of the solar spectrum falling on a phosphorescent surface rapidly discharged the phosphorescence.

Those who have investigated this subject are no doubt familiar with these facts, but they are mentioned here for the purpose of comparison with the observations made at low temperatures.

1. When a card covered with Balmain's paint was exposed to strong sunlight, taken into a dark room, and then immersed in liquified air (about 188° below zero C.) its phosphorescence was so reduced as to appear perfectly destroyed. When, however, this card was allowed to warm up gradually to the temperature of the room (20° C.) the phosphorescence again became active, being almost as bright as before immersion in liquefied air.

2. A phosphorescent card treated in the manner just described, except rapidly warmed to the temperature of the room (from—188° C.) by immersion in water at 20° C., was then compared with a card having had the same exposure to sunlight but not placed in liquid air. It was observed that the two cards presented little difference in luminosity, showing that the temporary reduction of the temperature of the one placed in liquid air had not resulted in an appreciable change in its phosphorescent energy. The card which had been in the liquid air was slightly the brighter of the two. This was to be expected, because the

discharge of its phosphorescence had been temporarily checked by the cold liquid bath, while the phosphorescence of the other card, which was at 20° C. throughout the experiment, was being discharged continuously; the latter, therefore, was slightly more exhausted.

3. Two cards similarly coated with Balmain's paint and which had been placed away from light for several days were exposed to the sun; one ('A') in the ordinary manner, and the other ('B') exposed while immersed in liquid air.

The cards were brought to the dark-room, and the one ('A'), that had not been subjected to the low temperatare, was immediately immersed in liquid air.

Both cards were then taken out of the cold bath and allowed to warm up gradually to the temperature of the dark room. Almost immediately card 'B', which had been exposed to sunlight while in liquid air, showed phosphorescence, appearing comparatively bright by the time the other card ('A') became luminous; the latter, however, getting rapidly brighter soon phosphoresced more strongly than the card 'B', which was exposed to the sun while immersed in liquid air.

This experiment was repeated many times with always the same result.

Several times the test card which had been exposed to the sun while in liquid air showed faint phosphorescence when still in the cold bath. On employing an electric arc, however, the Balmain's paint was made to phosphoresce much more strongly while at the temperature of liquid air than when using sunlight.

On repeating the experiment with two stop-watches it was found that the card 'B', exposed to the sun while in liquid air, required not more than 5 to 10 seconds to show phosphorescence distinctly, when allowed to warm up gradually to 20° C. in the dark room. The card 'A', simply exposed to the sun and immersed in liquid air in the dark, required 40 seconds as the average time to show luminosity.

In order to obtain an approximate value for the temperature corresponding to this time of 40 seconds, small sticks of wood, weighted with lead, were frozen to the test card with alcohol and afterwards with mercury. The cards were placed in liquid air and then allowed to warm up to the room temperature exactly as in the experiments on phosphorescence. The sticks frozen with alcohol fell from the test cards in 17 seconds, a value found by ten determinations, showing little variation from the mean. The sticks frozen with mercury fell from the card in 90 seconds. From this it was obvious that the 40 seconds required for the phosphorescence to become visible in the experiment mentioned above with card 'A' corresponded to a temperature between the melting point of alcohol and that of mercury, or a temperature of from 75° to 100° below zero C. Only this rough approximation of temperature was made because a more accurate determination would have had no general significance. This is evident when it is remembered that the phosphorescing power of different samples of the same material, the intensity of the light employed to excite a phosphorescent substance, and the sensitiveness of the eyes of different observers, all of which determine temperature values like that under consideration, are factors which are subject to considerable variation.

The results obtained in the foregoing experiments are in agreement with those published in the *Comptes rendus* by A. and L. Lumiere, already referred to. In the experiments of these investigators the electric arc was employed to excite phosphorescence in sulphides of calcium and zinc at normal temperatures; the phosphorescence produced was found to become invisible when these substances were cooled down from

normal temperatures to from $-45°$ to $-55°$ C.

When magnesium light was used as the exciting agent, the resulting phosphorescence did not become invisible until the substances were cooled to between $-70°$ and $-90°$ C. These temperature values might have been considerably different if other samples of the same phosphorescent materials had been used.

Other experiments by the undersigned were as follows:

4. A test card coated with phosphorescent paint was placed under a color screen, composed of strips of red, yellow, green and blue, transparent celluloid. The paint was then exposed to sunlight, both at 20° C. and at the temperature of liquefied air ($-188°$ C.). The phosphorescence produced at 20° C. was more intense than at $-188°$ C., but in the two cases the relative effects of the colored light appeared to be the same, blue light giving strong phosphorescence, while red light produced very little.

5. A test card ('A') of phosphorescent paint was exposed to sunlight for two minutes, the first at 20° C., the second at $-188°$ C. (in liquid air). The card was then taken into a dark room, where it became visibly phosphorescent when it had risen in temperature a few degrees above $-188°$ C. When this card was warmed to 20° C. it appeared equal in luminosity to a card 'B' that had been exposed one minute to the sun while in liquid air and then warmed to 20° C. Thus it appeared that the previous additional exposure to the sun of the paint on card 'A' of one minute at 20° C. did not appreciably increase the intensity of its phosphorescence.

The results of these experiments, as well as the observations of other writers mentioned above, indicate that the principal effects of very low temperatures on phorphorescence are as follows:

A. That the reduction of the temperature of a phosphorescing substance is accompanied by a corresponding decrease in the phosphorescent discharge.

B. That very low temperatures cause phosphorescence to linger long enough to be readily observed in a number of substances that are not visibly phosphorescent at normal and high temperatures.

C. That the production of phosphorescence in a phosphorescent substance is less when excitation occurs at low temperatures than when it takes place at high temperatures, other conditions being the same.

Furthermore, it appears as if, for a certain phosphorescent substance, different rates of phosphorescent discharge correspond to definite degrees of temperature, other conditions being the same, and that when an excited phosphorescent substance has been reduced to a very low temperature (even to $-200°$ C.), so as to show no phosphorescence, there is still some phosphorescent activity present. In such a case, however, the eye is not sensitive enough to detect the existing feeble luminosity.

A number of common substances show marked phosphorescence when reduced to the temperature of liquid air and then exposed to strong light; besides ivory and paper, already mentioned, are gum arabic, cotton wool, starch, white glue, celluloid and kid-skin.

The colors produced in the phosphorescence of these substances were observed to be as follows:

Gum arabic; decided light blue.
Ivory; bluish white. (Some pieces greenish.)
Cotton wool; bluish green,
Starch; yellowish green.
Paper; yellowish green.
White glue; greenish yellow.
Celluloid; greenish yellow.
Kid-skin (glove); decided green.

All of these substances were placed in filtered liquid air, exposed to an arc light,

and then examined in the dark. They remained bright at least half a minute, when kept at a low temperature after excitation.

Calcium tungstate was found to give phosphorescence decidedly green in color, after being exposed to an arc light, while at the temperature of liquid air, and then examined in the dark. When this substance is subjected to the influence of Röntgen rays the fluorescence produced appears white.

Experiments on the present subject will be continued when more liquefied air is procured.

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SCIENTIFIC BOOKS.

Synopsis of the Recent and Tertiary Leptonacea of North America and the West Indies. [Proceedings U. S. National Museum, Vol. XXI., Pages 873–897 (with Plates LXXXVII., LXXXVIII.) 1899.] By WILLIAM H. DALL. *The Mollusca of Funafuti.* Part I., *Gastropoda.* [Memoirs of Australian Museum III., Part 7, March 6, 1899.] By CHARLES HEDLEY.

In the first of these two very interesting and valuable additions to the literature of Malacology, Dr. Dall gives descriptions and figures of eighteen (18) new species and conveniently arranges all the known forms in the three lists —East Coast, West Coast, and Tertiary—showing that of the thirty-five east coast species enumerated, there are but two (*Kellia suborbicularis* and *Turtonia minuta*) which are found also on the west coast, the *Lasæa rubra* from Bermuda proving to be a distinct species. But four (*Kellia suborbicularis*, *Mysella planulata*, *Turtonia minuta* and *Aligena elevata*) are also found among the fossils. Many interesting changes are made in the synonymy, especially in the species from northeastern waters, some alteration in the name being made in every instance. They require the careful consideration of students interested in these small forms.

The combining of the recent genus *Kelliopsis* Verrill and Bush (1898) with the fossil genus *Aligena* H. C. Lea (1846) is unquestionably correct, but it is not made clear why *Abra æquata* Conrad (1843) (p. 877) is given as the type, and the two species (*A. striata* and *A. lævis*) described and figured by Lea fail to be mentioned even in the list of Tertiary species.

It is very doubtful if the combining of the genus *Mysella* Angas (1877) with *Montacuta* Verrill and Bush (1898) (the universally accepted interpretation of this genus), and the new interpretation of *Montacuta* Turton (1822), should remain unquestioned (p. 881).

In *Mysella* the hinge, the most important character, is described by Angas as consisting, in one valve, of a small, diverging, triangular cartilage-pit, close to which is a single, small, diverging, subcircular, flattened cardinal tooth; and, in the opposite valve, of two, thin, short, horizontal, lateral processes (P. Z. S. London, p. 176, 1877). The figures given of the only species (*M. anomala*) are entirely too small for accurate study and apparently resemble those of *M. substriata* as much as those of *M. bidentata*. It would seem improbable, however, that Angas could have failed to recognize the relationship of the Australian form to either or both of these well-known species. Probably with a more critical study of the specimen itself and with more material new points would be brought out, especially as it was placed by Angas between *Ervilia* and *Cytherea*, well separated from *Kellia*. In the species which Dr. Dall refers to *Montacuta* Turton, he describes and figures the hinge as having a prominent cardinal in each valve; the lamellæ obsolete; sockets for the resilium thickened and raised above the inner surface of the valve (*M. floridanum*, p. 893). The other species are similar to this, but he places the *Tellimya ferruginosa* Verrill (*non* Montagu) = *percompressa* Dall (p. 894) with them.

In an interior view of *percompressa*, the valves united, the dark brown resilium is somewhat triangular in form and lies underneath the beaks, fastened by its thin, inner edge to the sunken sockets which lie underneath the thickened posterior hinge-margin; its outer or upper edge is thick and broad, and bears an inconspicuous, thin, white ossicle. In one valve the anterior hinge-margin is thicker than in the

other and bears on its inner end a prominent, slender, somewhat curved tooth, having a blunt, concave end; in the opposite valve the hinge-margin is narrower, and the tooth, of similar form, is but little raised; a portion of the small, black or darker brown, external ligament, which separates the beaks and extends a little way on each side, passes between the valves and lies between these teeth, firmly attached to their concave ends. The dorsal margin is further attached, by the extension of the thin epidermis, for a considerable distance both before and behind the beaks.

The *Tellimya* Brown (1827) in its extended sense is synonymous with *Montacuta* Turton (1822). Brown divided his genus into three sections; the first included *suborbicularis* Montagu (the type of *Kellia* Turton (1822)); the second included *elliptica* Brown and *glabra* Brown, both = *ferruginosa* (Montagu), (recognized as the type of *Tellimya*, taken in a restricted sense), *bidentata* (Mont.) and *substriata* (Mont.) (type of *Montacuta* given by Woodward, 1851). Of the third section no examples were given. The hinge of this last species is carefully described by Jeffreys (Br. C., II., p. 206, 1863) as follows: "Cartilage yellowish-brown and semicylindrical, clasping the hinge-line on the posterior side of the beaks; hinge-plate short and narrow but strong, not deeply excavated in the middle; teeth triangular and pointed, that on the anterior side in each valve being larger than the other; the teeth in one valve lock into sockets in the other, but not in the corresponding valve of every specimen, it apparently being indifferent whether the right or left valve contains the more prominent teeth or sockets."

H. and A. Adams (1858) separated the two genera, placing *substriata* as the only example of *Montacuta* and both *bidentata* and *ferruginosa* as examples of *Tellimya*, but the definitions give no distinguishing characters. Sars in 1878 used *Tellimya* for *ferruginosa* (Mont.) and described and figured two new species, *nivea* and *ovalis*, and placed *bidentata* Mont., and *substriata* Mont., etc., under *Montacuta*. Professor Verrill also used *Tellimya* for the American form (*percompressa* Dall), thought to be a variation of the English *ferruginosa*, and gave in Trans. Conn. Acad., Vol. VI., p. 225, 1884, description and figures of the animal. The animal of the true *ferruginosa* was first described by J. Alder (Ann. Mag. Nat. Hist., p. 210, 1850). That Dr. Dall's interpretation of *Montacuta* appears synonymous with this is the probable reason for its not being used in his article. But that *substriata* and *ferruginosa* will prove generically related needs careful consideration, especially as no external ligament has been mentioned as found in *substriata*, and only separate valves have been found of each of Dr. Dall's new species.

Jeffreys (Proc. Zoöl. Soc., London, p. 696, 1881) proposed for the species described and figured by G. O. Sars as *Tellimya ovalis* the new name *Decipula ovata*; the new generic name, because *Tellimya* is a synonym of *Montacuta;* the specific, because he disapproved of the meaning of *ovalis*. As Sars' excellent figures show nothing that would generically separate *ovalis* from *ferruginosa*, *Decipula* becomes synonymous with *Tellimya*, but if the latter is discarded the former would have to be retained for this group. Jeffreys also made Sars' second species, *nivea*, a variety of *ferruginosa*. [See also Monterosato, Bull. Soc. Mal. Italian, Vol. VI., pp. 57–8, 1880.]

Montacuta planulata Stimpson (1851) was used by Professor Verrill in his Vineyard Sound Report (1874), but the great variations in size and relative thinness of texture in the American shells and their marked resemblances to a small series of English specimens led to the conclusion that in a larger series the same variations might be found and the English name *bidentata* was adopted. Dr. Dall finds that such variations do not exist, and again restores Stimpson's name (p. 890). This is not the *Lasæa planulata* Verrill (1879, Check-list) which is a large species of the same genus, measuring 8.5 mm. in length and about 7.5 mm. in height. It was dredged by the U. S. F. C. in Halifax harbor, in eighteen fathoms, 1877. It is thin, of delicate texture, covered with a conspicuous dirty-brown epidermis; the hinge-teeth are unequal in length and strongly resemble the figure given by Dr. Dall, of *Mysella Mölleri* (Hölbol) Mörch, so that there is no doubt that it is the same species.

It should be further noticed that in nearly every instance where the name of an Eastern Atlantic species has been adopted for species of our Western Atlantic fauna, even in those from deep water, Dr. Dall has either changed it or given additional varietal names, sometimes only for the very insufficient reason of differences in size, as in the instance of *Kellia suborbicularis* (Mont.) (p. 889), where only two specimens have been recorded from the coast: Thompson's *Gouldii* from New Bedford harbor and one from Massachusetts Bay, off Salem, U. S. F. C. (Verrill and Bush, 1898).

Such great dissimilarities exist in the hinges of the five figured species referred to the genus *Erycina* as to render it improbable that they can be retained in so close generic relation.

All these doubtful points will doubtless be satisfactorily adjusted by Dr. Dall in his more extended discussion of the subject, which is to appear in the Trans. Wag. Inst., Philadelphia, Vol. III., Pt. 5.

The *Lasæa rubra* Montagu quoted from Bermuda (p. 876) was found there abundantly by Professor Verrill and party, 1898. Compared with specimens from Guernsey it is found to have a much more swollen form with very large, swollen umbos, and attains twice the size of any of our numerous English examples. In one valve, anterior to the beak, there is a short, deep, socket, not sunken below the surface of the hinge-margin, but formed by two thin, triangular, raised teeth, nearly parallel—the outer one next to, and parallel with, the dorsal margin, and the inner one, much longer, diverging from the beak and curving outward from the inner edge of the moderately wide margin, the highest point of each being near the distal end. In front of this is a small, little prominent tooth on the inner edge of the hinge-margin, directly under, but separated from, the beak. There is also a similar socket, a considerable distance behind the beak, but it is longer and the two teeth are less triangular and but little raised, the upper or outer one scarcely discernible; within, and somewhat in front of this, separated and diverging from it, and running backward from the beak, is the sunken socket, to which a long, conspicuous, white resilium is attached. In other words, the hinge-margin broadens out distally, forming a triangular-shaped ledge at the side of this inner tooth, which has a concave side in which the resilium lies. In the English *rubra* the resilium is amber color and the teeth are not so strongly developed as in Bermuda specimens of the same size. In the opposite valve of the former there are three prominent teeth, the lateral ones well separated from the dorsal margin, which fit into these sockets and a corresponding resilium-pit. This distinct species may take the name *Lasæa Bermudensis*, sp. nov.

In the second article Mr. Hedley gives in his preface an interesting account of the atoll of Funafuti and the positions and conditions under which the various forms of mollusks are found, calling attention to the peculiarity in their lack of development, they being of smaller size than the representatives of the species from other localities. He also calls attention to the great difficulties encountered in preparing his article, owing to the great paucity of descriptive material.

Of the two-hundred and ninety-seven species, besides varieties, enumerated, about thirty-seven are described as new. Three new genera are also introduced (*Obtortio*, p. 412, type *Rissoa pyrrhacme* Melvill and Standen; *Cotumax*, p. 436, type *C. decollatus* sp. nov.; and *Thetidos*, p. 472, type *T. morsura* sp. nov.). The first is probably erroneously referred to Turbonillidæ, as there is nothing in the description or figure to suggest such a relation, so that a careful study of the animal is needed before such a question can be correctly determined. The second is placed with the Cerithiidæ, its nearest ally, *Cerithiopsis*; while the third is an addition to the Mangilliinæ but seems synonymous with *Nassarina* Dall (1889). Although the few figures given are unfortunately crude and coarse, they are of sufficiently large size to bring out the characters necessary for identification.

KATHARINE J. BUSH.
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'*Über die thermo- und piezo-elektrischen Eigenschaften der Krystalle des ameisensauren Baryts, Bleioxyds, Strontians und Kalkes, des Schwefelsauren Kalis, des Glycocolls, Taurins und*

Quercits.' W. G. HANKEL, Abhand. der math phys. Classes der K. Sächs. Gesell. der Wissen. Bd. XXIV. Pp. 471–496.

In this, the twenty-first paper by Professor Hankel describing his electrical investigations of crystals, the object, as before, is to determine the character and relative intensities of the electric charges developed at different parts of the crystals under the influence of temperature change or of pressure. From this distribution of the positive and negative charges conclusions can be drawn as to the true structural symmetry of the crystals. The methods were presumably those followed in previous investigations, as they are not described.

A. J. M.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Physical Review* for August contains the following articles:

'The Specific Heat of Solutions which are not Electrolytes,' by William Francis Magie.

'An Interferometer Study of Radiations in a Magnetic Field,' II., by John C. Shedd.

'The Effect of Magnetization upon the Elasticity of Rods,' by J. S. Stevens and H. G. Dorsey.

'On Freezing and Boiling Water Simultaneously,' by R. W. Quick.

Bird Lore for August opens with an article by R. Kearton, one of the most successful of the many photographers of wild animals, on 'Photographing Shy Wild Birds and Beasts at Home,' in which are explained some of the devices used by the Kearton Brothers. 'Two Nova Scotia Photographs,' by C. Will. Beebe, show in a very beautifully surrounded nest of Junco and a sleeping nighthawk. 'In the Spartina with the Swallows,' by O. Widmann, treats of a vast Western swallow roost in this writer's usual charming style and is accompanied by some interesting views. Bradford Torrey tells of 'Watching the Bittern Pump' and the various 'departments' are well filled, among the articles being a 'Round Robin' signed by well-known ornithologists, entitled 'Hints to Young Students' and justly deprecating the wholesale slaughter of birds and collecting of eggs under the impression that this alone is ornithology.

DISCUSSION AND CORRESPONDENCE.

ON GRADUATE STUDY.

IN the article, in SCIENCE for August 4th, 'Doctorates Conferred by American Universities,' in which you speak of the comparatively small number of university doctorates in the humanities, is found the following statement: "Our educational system is largely based on the study of language, and in view of the great number of teachers required it appears that they are satisfied with a less adequate education than is the case in the sciences." Every suggestion that looks toward improvement in the preparation of teachers, especially of the teachers in secondary schools, who seem most vulnerable in qualification in languages, should be warmly welcomed, but I am sure, however, that not all university teachers will agree with the conclusion quoted above.

It is certainly true, as your comparative table shows, that in American universities more candidates seek the degree of Doctor of Philosophy in the sciences than in the humanities, but it does not, therefore, necessarily follow that the persons who are engaged in teaching the humanities in our better colleges and universities 'are satisfied with a less adequate education' than is the case with their colleagues in the sciences, nor should a teacher's qualifications be measured by the number of degrees he possesses. As is well understood, language teachers often feel that they can do graduate work to better advantage in Europe, where they are constantly surrounded, as it were, by the very things they are studying; in fact, some American institutions decline to consider the applications of candidates for positions in French and German who have not studied abroad. These facts, and the additional fact that we now have better scientific laboratories in this country than was formerly the case, would perhaps partly explain the inequality in the number of doctorates conferred by American universities in the humanities and in the sciences. In this connection it is interesting to note that of the American students engaged in the study of these subjects at the University of Berlin during the summer semester of 1897 (I have no later statistics at hand) nearly twice as many were study-

ing the humanities as were matriculated in the sciences, or by actual count 63 % against 37 %.

Charles Bundy Wilson.
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Department of German.

NOTES ON THE NOMENCLATURE OF SOME NORTH AMERICAN FOSSIL VERTEBRATES.

In *Palæontological Bulletin* No. 16, p. 5, published August, 1873, Professor E. D. Cope described a new genus of rodents which he called *Gymnoptychus*. Of this genus he described at the same time four species, viz. : *chrysodon*, *nasutus*, *trilophus* and *minutus*. Later in a paper published in the *Seventh Annual Report of the U. S. Geological and Geographical Survey of the Territories*, on page 477, Professor Cope shows that he had determined that his *G. chrysodon* was identical with *Ischyromys typus*, described by Dr. Leidy in 1856. Accordingly *G. chrysodon* is recorded as a synonym of *I. typus*, while *minutus* and *trilophus* are retained under *Gymnoptychus*, the form *nasutus* being regarded as a probable synonym of *trilophus*. The same disposition is made of the species in Cope's *Vertebrata of the Tertiary Formations of the West*, except that *nasutus* is there made a synonym of *minutus*. It is evident that an error in nomenclature has been committed. Professor Cope nowhere definitely states which of his species he originally regarded as the type of *Gymnoptychus;* but, considering the way in which the species *chrysodon* is associated with the new genus *Gymnoptychus* and Professor Cope's practice in other cases, we are justified in believing that he regarded *chrysodon* as the type. But if this conclusion is contested there is indubitable evidence. The characters of *Gymnoptychus* are derived from the dentition of both upper and lower jaws ; and *chrysodon* was the only species of which he possessed both mandible and maxilla. It must, therefore, be regarded as the type of *Gymnoptychus*. Hence, when *chrysodon* was proved to be identical with *Ischyromys typus*, *Gymnoptychus* became a synonym of *Ischyromys*, and was no longer available as a generic name for the species which had been associated with it. These require a new generic name, and I therefore propose *Adjidaumo*, having for its type Cope's *Gymnoptychus minutus*. *Adjidaumo* is taken from Longfellow's *Hiawatha*. The known species are *A. minutus* and *A trilophus*.

Mr. E. S. Riggs has recently proposed in Field Col. Mus., Geol., Vol. I., p. 183, a new generic name, *Protogaulus*, for the reception of *Meniscomys hippodus*, since he considers that the species is not congeneric with the others which have hitherto been associated with it. This new genus Mr. Riggs arranges in the family *Mylagaulidæ*. Even if Mr. Riggs' views regarding the generic distinctness of *hippodus* and regarding its family relationships prove to be correct, he has proceeded in an improper way to express his conclusions. The type of the genus *Meniscomys* is the species *hippodus*, and in this genus it must remain, unless it can be shown either that *Meniscomys* is preoccupied or that it is a synonym of some earlier genus. *Hippodus* is provided for; it is the other species which are deprived of generic name by the removal of *hippodus*. They, however, may find lodgment under Marsh's *Allomys*. As the matter stands, *Protogaulus* is merely a synonym of *Meniscomys*, and both possibly synonyms of *Allomys*.

In the *American Journal of Science*, 1871, Vol. II., p. 125, Professor Marsh described, from the Bridger Eocene of Wyoming, a fossil carnivore which he called *Canis montanus*. This name, however, was preoccupied, having been employed in 1836 by Pearson. In the *Journal of the Asiatic Society of Bengal*, Vol. V., p. 313, he describes a fox which he called *Canis vulpes montana*. Although this animal is regarded by some as at most a subspecies of *Canis* (*Vulpes*) *alopex*, and although Professor Marsh's species probably belongs to a different genus, nevertheless, the latter species is shut out from the enjoyment of the name *montanus*. I shall apply to it the name *Canis? marshii*.

It is necessary to call the attention of paleontologists to the fact that the genus *Hypotemnodon* can not be employed for the two species which have been arranged under it. *Hypotemnodon* was proposed in 1894, by Dr. John Eyerman, in the *American Geologist*, Vol. XIV., p. 320, the type species being Professor Cope's *Temnocyon coryphæus*. But already, in 1890, in an article entitled 'The Dogs of the American Miocene,' published in the *Princeton College Bulletin*, Vol.

II., p. 37, Dr. W. B. Scott established the genus *Mesocyon*, basing it on the same species *coryphæus*. Dr. Scott seems to have afterwards forgotten his genus, since he employed Eyerman's name. Indeed, all paleontologists who have had occasion to mention the genus have called it *Hypotemnodon*. It is obvious, however, that it must yield to *Mesocyon*.

In 1865, in Proceed. Acad. Nat. Sciences of Philadelphia, p. 90, Dr. Leidy described, from the Eocene of South Dakota, a carnivore which he called *Amphicyon gracilis*. Unfortunately for his species, Pomel had, as early as 1847, employed the same name for a fossil carnivore found in Europe. Cope in 1884, in his Vertebrata of the Tertiary Formations of the West, p. 916, made Leidy's name a synonym of *Galecynus gregarius*. Scott and Osborn in 1887, in a paper in the *Bulletin of the Museum Comp. Zoology*, Harvard, Vol. XIII., p. 152, speak of it as a distinct species under the name *Cynodictis gracilis*. Matthew recently, in *Bulletin of the American Museum*, Vol. XII., p. 54, records it as an 'invalid species' and apparently as a synonym of *Cynodictis lippincottianus*. When those disagree who have access to the type specimens and to abundant materials belonging to related forms, it is evident that the last word has not been said. Until it can be determined with some degree of unanimlty where Leidy's specimens belong, it will be better to keep them to themselves under a distinct name. Furthermore, the possibility exists that the discovery of additional materials will prove Leidy's form to be a good species. Pending this settlement of the question I propose to call the *Amphicyon gracilis* of Leidy *Cynodictis hylactor*. The specific name is that of one of Actæon's dogs.

O. P. Hay.

U. S. National Museum, July 27, 1899.

THE PROPER NAME OF THE POLAR BEAR.

The technical name of the Polar Bear as usually mentioned is *Thalarctos maritimus* (Linn.), the reference being Systema Natura, X., 1758, p. 47. In looking up this reference I find it is simply mentioned under *Ursus arctos*, as follows: 'Ursus maritimus albus major arcticus'; with a reference to Martën's Spitzbergen, and concluding with a note doubting the specific distinctness of this bear. A question as to the value of this reference was referred to several noted authorities on the Mammalia, whose answer did not sustain the reference, and induced me to examine the case closer. The next date when any mention of the Polar Bear was made was 1776, when Müller and Pallas each gave it a name. Müller in his Zoologiæ Danicæ Prodromus, etc., p. 3, refers to it as a variety of *U. arctos*, calling it *U. albus*, but giving only a reference to Martën's Spitzbergen, and a short note on its habitat. Pallas, in his Reise, III., bh. 2, p. 691, describes this species as *U. marinus*, with a good diagnosis, which proves he knew the animal very well. As the name of Pallas is undoubtedly the best, being accompanied by a good description, therefore the name of the Polar Bear should be *Thalarctos marinus* (Pallas). The reference is Reise, III., bh. 2, p. 691, 1776.

James A. G. Rehn.

Academy of Natural Sciences,
Philadelphia, August 7, 1899.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

To the Editor of Science: A few days after contributing to your esteemed journal my remarks upon the bibliographical methods proposed for the Catalogue of Scientific Papers I received a report of a committee of Dutch scientists, whose conclusions are diametrically opposed in certain points to the opinions which I expressed. Impartiality requires that I should not pass this criticism unnoticed.

Let me translate from the French text: "The adoption of the Dewey Decimal Classification having been favored by certain persons, we wish to state our opinion in regard to this system. This opinion is very unfavorable. In our opinion the adoption of the system would lead to the failure of the enterprise.

"Our conviction in this matter is based upon the faulty manner in which the system has been worked out for various sciences in the 'Decimal Classification and Relative Index' of Mr. Dewey (1894, Library Bureau, 146 Franklin Street, Boston; 21 Bloomsbury Street, London).

It is possible that a classification such as is here proposed may serve for arranging a library containing principally popular science works or pedagogy, but for the end proposed by the International Catalogue it seems to us inapplicable. In regard to certain sciences, notably mathematics, physics, astronomy, it seems to us scarcely possible that there can exist in this regard a serious difference of opinion among persons really competent to judge.

"Furthermore, we reproach the system as worked out by Dewey with being inelastic. In view of the very restricted number of places left vacant, the addition of new subjects of a fundamental character can soon be accomplished only by very artificial means, and, moreover, it would require the use of a disproportinate number of the former figures."

On reading this report one can hardly fail to be struck with the emphasis that has been laid upon the book that has been used as an authority, pains being taken to give even the street number of the firm selling the work in Boston and in London. This emphasis is, of course, in part, due to the fact that the committee wished to prove that its criticism was not made without examining the 'Decimal Classification' of Dewey, a neglect which has been admitted by certain other critics. But to those who have followed the matter closely it will be apparent that this assertion has a deeper meaning. It is a frank declaration that the committee declines to examine the application of the decimal system to card bibliographies. Dewey, as is well known, never proposed the use of his system for bibliographies. It is an application which I believe was first made by Mr. Pickford Mann, but which has since found wide extension largely in consequence of the effort of the International Institute of Bibliography in Brussels. Now, this statement is intended as a disavowal of these applications. Such a proceeding is manifestly unfair. What should we say of a person who should insist upon using a work dealing with electric lighting as an authority for judging the possibility of utilizing electricity for telegraphy? The Brussels Institute took the decimal system, expanded certain parts according to the principles expounded by Dewey, added a few distinctive signs, such as the colon and the parenthesis, and at once the system attained the extreme pliability requisite for bibliographic purposes. For library purposes pliability is a fault, a work on the Locusts of Mexico can not be duplicated under Locusts and under Mexico; but for bibliography this is a *sine qua non*. Moreover, the success or failure of the system in libraries is no valid argument respecting its use for card bibliographies. In library organization the question is whether or not a methodical arrangement of the books according to subject-matter be possible and practical. Where the decimal system has failed, it will be found to have been the strict methodical arrangement that has been found impractical. But for bibliography the arrangement by subject-matter, however difficult to attain, is essential, and *for cards* this presupposes some system such as the decimal system.*

The report states that for various sciences the system has been worked out in such a faulty manner that it seems scarcely possible for a divergence of opinion to exist. The sciences that are selected as examples differ from those mentioned in the memorandum of the Royal Society's Committee. According to the Dutch report, mathematics, astronomy and physics can not be dealt with in this way. To deny the possibility of a divergence of opinion in this regard is certainly too strong. I have laid the matter before the representatives of these sciences in Zürich, and two of them declare themselves pronounced advocates of the decimal system; the third believes it perfectly applicable. For mathematics, Professor Rudio, who has been watching the movement for a year past, feels that certain changes are necessary and pointed out the modifications necessary to bring the scheme into harmony with the Jahrbuch. It is, indeed, my conviction that the objections raised relate to the fact that the classification is conventional, not scientific. But it is easy to show that this is no valid ob-

*It is important to note that, out of over one thousand divisions used by Dewey in the part worked out by the Concilium Bibliographicum, only three have been modified. This is a sufficient answer to those who claim that the system must be totally remodeled.

jection; on the contrary, a classification embodying the latest scientific conceptions is seldom fit for bibliographical work. In the Dutch Academy of Sciences ridicule was cast upon the decimal system because physiology was made a sub-division of medicine. Scientifically it is absurd; bibliographically it is the only wise course. The literature of the past century passes insensibly over into medicine, and a system disregarding this historical fact would be extremely faulty. All attempts at a strictly scientific classification must be personal and liable to change. Most zoologists place *Limulus* with the Arachnids; bibliographically this would be folly. Arachnidologists, collecting the spiders of the various countries of the world, have not yet, at least, become so impressed with this kinship that they seek the seas for *Limulus*; while the malacologists persistently add *Limulus* to their lists of captures. The bibliographical system should correspond with the customs of authors; it is not intended to teach taxonomy.

The assertion that the decimal system is inelastic scarcely needs comment. The system was first published in 1876, with 1,000 divisons, requiring 12 pages of print; to-day by simple expansion nearly 50,000 divisions, filling 400 pages, having been added. For certain sciences the expansion has been continued still further. Indeed, there are now far more divisions in our simple zoological tables than in the entire original work. In certain trials leading up to the establishment of the final system used by the Concilium Bibliographicum the attempt was made to proceed by successive sub-divisions down to families and sub-families. In this experiment as many as a thousand new divisions were introduced at a single point in the series; it is needless to say that no inconvenience was experienced.

It is a pity to see cautious men of science make assertions like this, which have not the slightest foundation in fact. They are so plainly based upon gross misconception that one might well pass them by in silence were it not that they are liable to have weight in deciding one of the most vital questions now before the scientific world.

Herbert Haviland Field.

NOTES ON INORGANIC CHEMISTRY.

The paper read by Collie and Tickel before the Chemical Society (London) on the quadrivalence of oxygen, as shown by the probable constitution of dimethylpyrone, 'an oxygen base' has been recently noticed in this column. In this paper the authors mention that in 1888 J. F. Heyes advocated a similar view to account for such peroxides as MnO_2 and BaO_2. In the last *Chemical News* C. T. Kingzett calls attention to the fact that in a paper before Section B at the Southampton meeting of the British Association, in 1882, he reviewed the modes of formation of ozone and hydrogen peroxid, arguing for the variable valence of oxygen, and adds: "I am not aware that anyone had previously represented oxygen as a tetrad." Being present at the Southampton meeting, I remember Mr. Kingzett's paper very well; indeed, I was so much impressed with it that I have since used the formulæ $O=O^{iv}=O$ and $H_2O^{iv}=O$ in my teaching. I recall, however, that after the session one of the members remarked to me: "Kingzett is right, but there is nothing new in it; I have been teaching that for a number of years." It has long seemed strange to me that the idea of the variability of oxygen's valence has had so few advocates, especially when its position in the periodic system is considered.

In a recent number of the *Archiv der Pharmacie* a new method of detecting arsenic in fabrics is given by O. Rössler. A small piece of the goods is burned in the upper part of a Bunsen flame in a fine platinum spiral, and the arsenious oxid formed collected on the outside of a porcelain dish filled with cold water. The deposit, which is hardly visible, is moistened with silver nitrate. On subsequent fuming with ammonia the yellow precipitate of silver arsenite becomes visible, and then disappears by solution in more ammonia. No data are given as to the delicacy of the reaction, but it must be vastly inferior to Reinsch's test, except for such compounds of arsenic as are wholly insoluble in hydrochloric acid. In the case of the sulfids of arsenic Rössler's test might have a considerable value, as the quantity of arsenic present in such a yellow pigment is not small.

It was only after much experimenting that Tyndall succeeded in obtaining absolutely optically-pure air, so clear that the path of even the most intense light is invisible. In experimenting upon water Lallemand was unable to obtain optically-pure water, and was led to question its existence. Professor Spring, of Liège, has, however, succeeded in thus purifying water and an extended account of his work is given in the *Bulletin* of the Royal Academy of Belgium. That the visibility of the path of a ray of light is due to suspended matter is shown by the fact that in the optically-pure water of Spring the path is wholly invisible. Such water cannot be obtained by distillation, nor by filtration, these processes having no tendency to purify water optically, but often rather the contrary. Optically-pure water can be obtained by the action of a weak high-tension current on water which contains suspended matter, or by sedimentation of colloidal precipitates, such as aluminum, ferric, etc., hydroxids, or by filtration of the water through colloidal precipitates. Crystalline precipitates, such as calcium oxalate, have little or no effect; nor can organic liquids be purified by colloidal precipitation. Spring believes that the illumination of the water is probably not caused by the dust itself, but by minute bubbles which adhere to the dust particles. These occasion different colors, in which red and orange predominate, and hence the blue color of natural waters cannot be due to a selective absorption on the part of the suspended matter. J. L. H.

THE BRITISH MUSEUM.

A RETURN dealing with the British Museum has been issued in the form of a Blue-book. We learn from a report in the London *Times* that it contains an account of the income and expenditure of the British Museum (Special Trust Funds) for the year ended March 31, 1899; a return of the number of persons admitted to visit the Museum and the British Museum (Natural History) in each year from 1893 to 1898, both years inclusive; together with a statement of the progress made in the arrangement and description of the collections and an account of objects added to them in the year 1898.

Part VI. of the return, which gives an account of the general progress at the Museum at Bloomsbury, states that the number of visitors to the Museum in the year 1898 is the highest on record since the year 1883, amounting to a total of 612,275, as against 586,437 in 1897. The visitors on Sunday afternoons numbered 41,858, as against 37,594 in 1897. The total number of visits of students to the reading room during the year was 190,886, a slight increase on that of the previous year, which was 188,628. The daily average was 627, as against 624 in 1897. The number of volumes, etc., supplied to readers in the year was 1,397,145, as against 1,419,159 in 1897. There has been a marked increase in the number of visits of students to the several other departments other than the reading room. The total amounted to 48,214, as against 40,976 in 1897. This increase is partly to be attributed to the extension of students' rooms. The new building commenced last year for the accommodation of the bookbinders has been completed, and the bookbinding staff has been transferred thither. The basement rooms of the Museum which have thus been vacated are being fitted for the storage of newspapers.

The part of the return relating to the British Museum (Natural History) states that the total number of visitors to the Natural History Museum in 1898 was 419,004, as compared with 422,607 in 1897. The slight falling-off shown in these figures has taken place in the weekday visitors, the Sunday attendance for the year (50,432) being a little in excess of that for 1897. The average daily attendance for all open days during the year was 1,151; for week-days only, 1,181; and for Sundays, when the Museum is open only in the afternoons, 970. The new whale room was opened to the public on Whit Monday, May 30, 1898, and has been much appreciated by visitors. A photographic studio has been erected at the back of the Museum. Renewed application has been made to the Lords Commissioners of the Treasury for funds for lighting the galleries and studies of the museum by electric light, and a sum of £2,000 has been provided for 1899–1900 for the introduction of the light into the work rooms and studies.

Important acquisitions by purchase have been made during the year, among which special mention may be made of the Norman collection of marine invertebrates and land and fresh-water shells (first instalment, consisting of over 26,000 specimens); a complete skeleton of an aboriginal Tasmanian, a race now extinct; a specimen of the rare mollusc *Pleurotomaria beyrichii* from Japan, the only living specimen yet discovered; an entire specimen of the rare elasmobranch fish, *Squatina alifera*, from the lithographic stone of Nusplingen; a valuable and unique collection of fossil insect remains formed by the late Rev. P. B. Brodie (4,700 specimens); the Piper collection of fossils from all the strata of the Ledbury Tunnel (1,806 specimens); and a selection from the late Rev. T. T. Lewis's collection of old red sandstone fishes, &c., of historic interest as having been specially studied and referred to by Sir Roderick Murchison. The number of separate presents reported as having been received during the year by the several departments of the Museum was 1,610, as compared with 1,622 in the preceding year. Many of these comprised a large number of individual specimens.

UNIFORMITY IN SIZE OF PAGES OF SCIENTIFIC PUBLICATIONS.

A COMMITTEE of the British Association for the Advancement of Science was appointed in 1896 to secure, if possible, uniformity in the pages of scientific transactions and journals. It has already issued one report on the subject, and now, in a circular letter, strongly recommends that there should be but two standard sizes, octavo or quarto form, with the following dimensions, as issued with pages uncut:

1. *Standard Octavo Size.*—Pages 14 by 22 cm., or $5\frac{5}{8}$ in. by $8\frac{3}{4}$ in.

From stitching to outer margin of letterpress, 12 cm., or $4\frac{5}{8}$ in.

Height of letterpress including running headline, 18 cm., or 7 in.

Limits: pages not less than 14 by 21.5 cm., or $5\frac{1}{2}$ in. by $8\frac{1}{2}$ in.

Letterpress not more than 12.5 cm., or $4\frac{7}{8}$ in., from stitching, and 18.5 cm., or $7\frac{1}{4}$ in., high.

2. *Standard Quarto Size.*—Pages 22 by 28.5 cm., or $8\frac{3}{4}$ in. by $11\frac{1}{4}$ in.; letterpress 18.5 cm., or $7\frac{1}{4}$ in., from stitching to outer margin of letterpress, and 21.5 cm., or $81\frac{1}{2}$ in., high.

Limits: pages not less than 21.5 by 28 cm., or $8\frac{1}{2}$ in. by 11 in.

Letterpress not more than 19 cm., or $7\frac{1}{2}$ in., from stitching, and 23 cm., or 9 in., high.

In order to secure satisfactory binding together, the printed area should be small enough not only to escape being cut into, but also to leave a reasonably large margin, and the paper used should be large enough always to reach to the cut edge of a bound volume. Plates should be folded within the standard sizes so as not to be injured when the edges of the book are cut in the binder's press. It is also recommended that every article should always begin at the top of a right-hand page, even if that involves a blank left-hand page, so that a paper can be extracted from a journal without mutilating one or the other.

We fear that these recommendations can scarcely be carried out in the United States. A majority of our leading scientific journals are of a size almost exactly intermediate between the standard octavo and standard quarto forms. The convenience of this size seems to be indicated by the fact that it has been chosen by the committee for the publication of their report

STANDARD MEASURING INSTRUMENTS.

THE Committee of Standards for Instruments of Measure, of the American Chemical Society, consisting of Messrs E. E. Ewell, chairman; Louis A. Fischer, H. P. Talbot, C. E. Linebarger and G. E. Barton, have drawn up a report which has been adopted by the Council. This is as follows:

Your committee, to which you have assigned the duty of making a study of the means by which the American Chemical Society can hasten the adoption of uniform systems of graduation, definite limits of accuracy, and standard methods for using all forms of measuring instruments employed in chemical laboratories, beg to make the following preliminary report:

The committee was promptly organized by correspondence after its members had been notified of their appointment by the proper officer of the Society. After much discussion the com-

mittee decided to take up first the consideration of the proper form, system of graduation, limits of accuracy, manner of labelling, and methods of using glass volumetric apparatus. The committee has made a careful study of the work that has already been done in other countries on the subject, an account of which is given on pp. 527–550 of the Journal of the Society.

Your committee accordingly submits the following recommendations for your consideration:

1. That the American Chemical Society, in a manner consistent with its constitution and by-laws, ask the U. S. Office of Weights and Measures to adopt regulations for the verification of volumetric apparatus which shall be similar in purpose and scope to the regulations of the Kaiserliche Normal-Aichungs-Commission, after due consideration of the criticisms to which the latter have been subjected.

2. That the U. S. Office of Weights and Measures be asked to give special consideration to the question of a standard temperature or temperatures to be adopted for the graduation of volumetric apparatus, and to obtain as far as practicable an expression of opinion from American chemists on this point.

3. That the U. S. Office of Weights and Measures be asked to submit its regulations to the American Chemical Society, or a duly appointed committee thereof, for suggestions before final adoption by that office.

4. That the international kilogram be adopted as the standard of mass.

5. That the liter as defined by the International Committee on Weights and Measures, be adopted; *viz.*, the volume of the *mass* of a kilogram of pure water at the temperature of maximum density and under a pressure of 760 mm. of mercury.

6. That all density determinations be referred to water at its maximum density and under a pressure of 760 mm. of mercury.

7. That all temperatures be expressed in terms of the hydrogen thermometer of the International Bureau of Weights and Measures.

8. That if any question arise as to the interpretation of the above definitions the decision and standards of the U. S. Office of Standard Weights and Measures shall be accepted by the Society as final.

SCIENTIFIC NOTES AND NEWS.

THE American Association for the Advancement of Science is holding, at Columbus, Ohio, its 48th annual meeting as we go to press. We are able to publish, this week, the address given on Monday by the retiring President of the Association, Professor F. W. Putnam, and the address, before the Section of Physics, of the Vice-President, Dr. Elihu Thomson.

PROFESSOR ROBERT WILHELM EBERHARDT BUNSEN, the great chemist, born at Göttingen, on March 13, 1811, died at Heidelberg, on August 16th.

THE death is announced of Sir Edward Frankland, K.C.B., F.R.S., the eminent chemist. Born in 1825, he was educated in the Royal School of Mines, London, and in German universities under Bunsen and Liebig. He was successively professor of chemistry at Owens College, Manchester; at the Royal Institution, London, and at the Royal School of Mines, London. He was the author of works on chemistry and water analysis, and is perhaps best known for his inquiries into the polution of rivers and his reports on the water supply of London. He had been President of the Chemical Society and was Honorary Secretary of the Royal Society. His son is Dr. Percy Faraday Frankland, F.R.S., professor of chemistry at Mason College, Birmingham, and a leading authority on bacteriology.

ON August 2d Queen Victoria conferred the honor of knighthood upon Sir William Henry Preece and Sir Michael Foster, Knight Commanders of the Order of the Bath.

THE Neill Prize for 1895–98 has been awarded to Professor J. Cossar Ewart, M.D., F.R.S., by the Royal Society, Edinburgh, for his experiments and investigations bearing on the theory of heredity.

THE Pharmaceutical Society of Great Britain has awarded the Hanbury Gold Medal to Professor Albert Ladenburg, for his work on alkaloids and their derivatives.

THE Alvarenga Prize of the College of Physicians of Philadelphia has been awarded to Dr. Robert L. Randolph, of Baltimore, for his essay entitled 'The Regeneration of the Crystalline Lens: an Experimental Study.'

Dr. William Z. Ripley has recently been elected a corresponding member of the Società Romana di Antropologiá and of the Société des Sciences Mathematiques et Naturelles de Cherbourg.

Nature states that Mr. J. S. Budgett, of Trinity College, Cambridge, who accompanied Mr. Graham Kerr on his expedition in search of *Lepidosiren*, has been successful in obtaining eggs and larvæ of the Crossopterygian Ganoid *Polypterus*. From a short account of his investigations, illustrated by sketches, which Mr. Budgett has sent to England, it appears that the larva is very minute, and possesses a 'cement organ' on the dorsal surface of the head.

The death is announced of M. N. Rieggenbach, Correspondent of the Paris Academy of Science in the Section of Mechanics.

The will of Mr. George Averoff, who died, at Alexandria, on July 27th, gives large sums to educational and other public institutions. Among these is a bequest of £20,000 to create an agricultural school in Thessaly and one of £50,000 to the Polytechnic Schools at Athens.

A British departmental committee, with Sir Hubert Maxwell as chairman, is investigating preservatives and coloring matter in food.

The Commissioners for the Exhibition of 1851 have made appointments to Science Research Scholarships for the year 1899, on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result in work of scientific importance. There were this year six students appointed for a third term, twelve reappointments and sixteen new appointments. Of the two classes first mentioned the place of study is designated. This is as follows: Cambridge University, 6; Owens College, Manchester, 3; Leipzig University, 3; Central Technical College, London; University College, London; Harvard University, Berlin University and the Marine Biological Laboratories, each 1.

The Labrador mail steamer reports that the Peary expedition steamer *Diana* passed Domino Run, northern Labrador, at two o'clock in the afternoon of July 24th. All on board were well at that time. The *Diana* hoped to reach Disco, Greenland, by July 29th.

A reunion of the British Institution of Electrical Engineers is arranged to be held in Switzerland from the 1st to the 9th of September inclusive. The *Times* states that the members will assemble at Basle, and on September 2d will visit the Rheinfelden electrical power station, and will proceed on the same day to Zurich, where they will remain until September 6th. During that time visits will be made to establishments and places of electrical interest, including the works of the Oerlikon Company, those of Messrs. Brown, Boveri & Co., the Dowson gas-generating station of the Zurich-Oerlikon Street Railway, Messrs. Escher, Wyss & Co.'s works, the municipal central electric lighting station and sub-station of Zurich, the new electrical power station at Schaffhausen, and the Falls of the Rhine. There will also be a visit to the iron and steel works of Messrs. George Fischer and to the National Museum at Zurich. In the evening of September 5th a banquet will be given to the visitors by the Swiss firms and the Schweizerischer Elektrotechnisher Verein. On the evening of September 6th the members will leave for Lucerne, where they will inspect the street railways, the Rathhausen Works, and the Stansstad-Engelberg Railway. They will then proceed direct to Interlaken, via the Brünig Pass, and on September 8th will visit the Jungfrau Railway, via Lauterbrunnen and the Wengern Alp Railway, the power station at Lauterbrunnen also being inspected. On September 9th there will be a visit to the Kander Werk at Spiez (central station for light and power distribution) and to the Burgdorf-Thun Electric Railway, which will bring the reunion to a close. In order to con-

tribute to the comfort of the members, especially the ladies of the party, it has been arranged that evening dress will not be required during any portion of the visit.

THE opening meeting of the Sixth International Otological Congress took place in London on August 8th, under the presidency of Professor Urban Pritchard, who delivered an address on the 'Birth and Growth of Otological Science.'

RICHARD ANDRE, in an editorial note in a recent issue of *Globus* deprecates the term 'Amerind' that has been proposed by the Anthropological Society of Washington in place of the current terms 'American Race,' 'Indians' and 'Red Men.' He doubts the necessity of introducing a new term and considers the change as arbitrary and as 'unhistorical.'

AN extensive series of experiments has been in progress during the summer, in the neighborhood of Shelter Island, by Mr. John P. Holland, the inventor of the Holland Torpedo Boat, in the investigation of the various problems of submarine navigation and warfare. The Holland submarine boat has been kept busy in these experiments, and it is said has performed remarkably well. This is the craft lately built at Mr. Nixon's shipyard at Elizabethport.

Nature quotes from the special number of the *Atti*, containing the report of the anniversary meeting of the Reale Accademia dei Lincei, announcing the annual awards of prizes. The Royal prize for astronomy for 1896 remains unawarded. The Royal prize for philology and languages is divided equally between Professor Pio Rajna, for his critical edition of Dante's 'De Vulgari Eloquentia,' and Professor Claudio Giacomino, for his studies on the Basque language. The prize for history and geography is unawarded, and the same is true of a prize offered for 1898 for perfecting the theory of motion of a rigid body. The Ministerial prize of 3,400 lire for history for 1898 is divided, a prize of 1,700 lire being awarded to Professor Gaëtano Salvemini, and smaller awards being made to Professors Alberto Birro, Niccolò Rodolico and Michele Rosi. Of the Ministerial prize of 3,400 lire for mathematics for 1898, a prize of 2,000 lire is awarded to Professor Ettore Bortolotti, and awards of 700 lire each are made to Professors Federico Amodeo and Francesco Palatini. The adjudicators state that the works of Professor Pirondini would have gained an award had not some of them received recognition on a previous occasion. The adjudicators of the Ministerial prize for philosophical and social sciences for 1897 award 500 lire each to Professors Albino Nagy, Luigi Ambrosi and Tarozzi. The Mantellini prize is unawarded. Of the Santoro prize for electro-technics, one-half is awarded to Signor R. Arnò, for his share in the joint invention with the late Professor G. Ferraris of a new transformer. The Santoro prize for chemistry as applied to agriculture is unawarded, and from the Carpi prize for mathematical physics for 1897–8 a sum of 500 lire is awarded to Signor C. Canovetti, for his papers on the direction of aërostats and on the the resistance of the air.

THE London *Times* reports that the city and environs of Rome were visited on July 19th by a prolonged and relatively severe shock of earthquake, which, while damaging various edifices in Rome itself and doing considerable harm at Frascati, Rocca di Papa and other towns on the Alban Hills, fortunately passed without causing loss of human life. The shock occurred between 2:19 and 2:20 p.m., lasting with minor intensity for twenty-five and with major intensity for about six seconds. A dull noise like the sound of a heavy dray being driven rapidly under an archway accompanied the phenomenon, which was mainly undulatory in character. In many parts of the city the terror-stricken inhabitants rushed into the streets and public gardens, where they were soon drenched by a deluge of torrential rain from light gray clouds which gathered almost instantaneously in what had previously been a perfectly clear sky. The city did not regain its normal aspect until 5 p. m. Several minor casualties are reported. A workman was injured by a falling brick; a horse was killed by the collapse of a stable; a fragment of masonry fell from a church, smashing four paving-stones and narrowly missing a passer-by. The Palazzo Sciara and the Palazzo Chigo in the Corso were slightly damaged; a large stone fell

from the Colosseum; the columns in the Forum were seen to rock, but remained intact; a small fissure appeared in the recently-discovered Lapis Niger, but quickly closed again; some unfinished jerry-built houses collapsed in an outlying quarter of the city.

THOUGH the matter is not one of special scientific interest, it may be mentioned that Mr. J. C. Stevens, London, sold recently a good specimen of the egg of the great auk (*Aleca impennis*), which was one of the three formerly in the collection of the Comte Raoul de Berace. This specimen, which is slightly cracked, was figured in the Memoirs of the Société Zoologique de France in 1898, and with additional notes on its history, it also appeared in the *Bulletin* of the Société in 1891. Bidding started at 100 guineas, and at 300 guineas it became the property of Mr. Middlebrook, of Regent's Park. This is the same price which Sir Vauncey Crewe paid for his specimen in 1894. There are in existence about 51 recorded specimens of the great auk's egg.

THE India-European Telegraph reports from Allahabad that a case of scientific interest has occurred at Meerut, where a snake-bitten patient was cured by the injection of Calmette's serum, the efficacy of which had already been made probable by laboratory experiments. The patient had all the symptoms of colubrine poisoning fully developed, and the case was so critical that artificial respiration was found necessary until the serum had time to take effect.

EXPERIMENTS by Professor Tuma and a number of officers of the Vienna garrison to test the possibility of wireless telegraphy between two balloons on July 14th, says the London *Times*, were attended with a certain degree of success. A balloon held captive at a height of 150 metres served in place of the mast used in the Marconi experiments, being connected with the despatching instruments on the ground by a copper wire. The second free balloon carried a receiving instrument and a wire which hung loose 20 metres below the car. In these conditions it was found possible to communicate with the three officers in the free balloon, who signalled with flags that they had received and understood the telegraphic messages. These signals were observed at an estimated height of 1,600 metres and a distance of about 10 kilometres from the despatching station. Owing to the size and weight of the accumulators and the great danger of bringing them into close proximity to a large volume of explosive gas, it is thus far impossible to telegraph from a balloon to the ground or from one balloon to another. On the return to Vienna of the officers a comparison will be made between the detailed particulars noted by them and the report of the actual messages despatched.

AN interesting experiment, says the *British Medical Journal*, which was made in Mentone last autumn with the view of diminishing, if not of exterminating, the mosquito—one of the pests of some parts of the Riviera, especially in October and November—is related by Dr. Samways. In an article published in the *British Medical Journal* last September an account was given of a method of using kerosene recommended by Mr. L. O. Howard, Entomologist to the United States Department of Agriculture, for this purpose. The plan depends upon the fact that kerosene, commonly called paraffin in Great Britain, is fatal to at least some of the species which are called mosquitos. A very small quantity dropped on a pool quickly spreads itself over the surface, and, it is alleged, destroys the larvæ, while at the same time it kills any adult female which attempts to alight with the object of depositing her eggs. The efficacy of kerosene has been disputed, as it has been asserted that the immature mosquito is able to thrust the tip of its respiratory apparatus through the thin film of paraffin. The species of mosquito upon which the experiment was made does not appear to have been identified, but it was probably a culex. The larva of culex floats head downwards, while that of anopheles, which is believed to be the bearer of the malarial parasite, floats horizontally, so that there would be, *a priori*, some ground for expecting that the latter would be more easily killed than the former. It was estimated that there were as many as 400 or 500 larvæ in a bucket of water from the tank in Sir Samuel Hayes's villa, where the experiment was made. All were found to be

killed within an hour or two of the addition of five drops of kerosene, and the many thousands in the tank, which was of nearly 300 cubic feet capacity, were killed by a teaspoonful in a few hours. The experiment is so simple and inexpensive that there seems no reason why it should not be tried on a more extensive scale in other places.

ACCORDING to private advices received from India, says the London *Times*, the Board of Trustees constituted last spring to carry out the scheme approved by the Bombay Legislative Council for preventing a recurrence of the plague has already notified for execution four plans of reconstruction affecting a large insanitary section of the city and involving the laying-out of six miles of new streets. The estimated cost of these projects is Rx.1,820,000. They are designed on the recoupment principle, which was essential in view of the magnitude of the building operations which will have to be carried out on both sides of the new thoroughfares. The general idea of the scheme, the initiation of which was due entirely to Lord Sandhurst, who has devoted much time and personal attention to the city of Bombay, is to deal effectually with the insanitary conditions of the place by removing 'rookeries' and 'slums,' and by providing wide thoroughfares in over-crowded localities very much on the lines which have been so successfully followed in Glasgow, Birmingham and other British towns. The Bombay scheme, however, goes further and deals also with a more serious condition of affairs. It includes provision for the extension of the city by reclaiming large areas on the foreshore of the island as well as the opening out of wide roads, the removal of insanitary dwellings, and the erection on a very extensive scale of new dwellings for the working classes. The Board of Trustees, to which is entrusted the task of carrying out this work, is subsidized by the Corporation of Bombay and endowed with the usufruct of certain valuable building areas belonging to government and the corporation, within the city limits; also with the right of reclamation on the foreshore outside the limits of the port. The Board consists of 14 Trustees, partly *ex officio*, partly elected and partly nominated, and all the chief interests concerned are fully represented. It has special powers to acquire property required for or in connection with the several schemes to be undertaken, and power, with the sanction of the government, to raise loans. The scheme involves a new departure of some moment, and its operation will be watched with considerable interest. In a Western city the project would undoubtedly have been left to the ordinary municipal organization, but in India, although local self-government has developed amazingly, it is no disparagement of that principle to question its efficiency for carrying out improvements dealing with vested interests on an enormous scale, and requiring years of persistent effort on systematic lines for their due accomplishment, in addition to the task of administering the ordinary affairs of a great city.

SIR ROBERT S. BALL, in his annual report of proceedings in the Cambridge Observatory for the year ended May 25, 1899, states, according to the report in the London *Times*, that during this period the meridian circle has been used, as in the previous year, for the perfection of the catalogue by re-observing stars, of which not more than two observations had been obtained, in order to carry out the original design that each place should depend on not less than three observations. To this end 2,241 observations have been taken of 1,429 stars; 58 are still insufficiently observed, and five have not yet been re-observed. The intervals of the transit wires were determined afresh, at the beginning of this year, from 115 observations of Polaris made in 1898, and tables were constructed for facilitating the reductions to center wire. These intervals have been used since the beginning of 1899. A very important addition to the instrumental equipment of the Observatory has been made during the past year by the erection of the new equatorial, which will be known as the Sheepshanks equatorial. A machine for measuring the photographs has been designed, and is now being constructed by the Cambridge Scientific Instrument Company. It is essentially a form of the instrument designed by Professor Turner for the work of the astrographic chart, modified to give the greater accuracy required in stellar parallax work. The syndicate have pleasure in announcing that they have re-

ceived from a donor, who wishes to remain anonymous, a donation of £50 towards the expenses of making a catalogue of books in the library. Preparations have been made for the complete arrangement and cataloguing of the books during the present summer. The number of members of the University attending Mr. Hinks's classes in practical astronomy shows an encouraging increase. The Newall telescope has been used for observations on 96 nights in the course of the year 1898 (May 19th)–1899 (May 19th). In November and December there were 33 consecutive nights on which clouds rendered it useless to attempt observations. In continuation of the work referred to in last year's report the instrument has been employed in connection with the Bruce spectroscope in taking photographs of stellar spectra for the determination of velocity in the line of sight. In the course of the year 150 photographs (in addition to many others rejected for various reasons) have been obtained, giving material available for the determination of the velocity of 60 stars. Preparations are well advanced for converting the Bruce spectroscope into a powerful four-prism instrument, which is to be used in securing material for a detailed examination of the spectra of a few of the brightest stars.

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. Arthur T. Hadley will be formally inaugurated President of Yale University on October 18th. The occasion will be of special interest, as Dr. Hadley will deliver an address, which will doubtless outline the policy of the University for many years to come.

The University of Berlin celebrated on August 3d the 90th anniversary of its foundation by Frederick William III. The oration was delivered by the retiring rector, Dr. Waldeyer, professor of anatomy, who took as his subject, 'Does the University of Berlin fulfill the mission entrusted to it by its founder?' Dr. Waldeyer is succeeded as rector by Professor Fuchs, the distinguished mathematician.

Nature states that the Research Fellowships founded by the Salters' Company and the Leathersellers' Company for the encouragement of higher research in chemistry in its relation to manufactures tenable at the City and Guilds Central Technical College, being now vacant, the Executive Committee of the City and Guilds of London Institute will, before the commencement of next session, consider applications and elect candidates. The grant made by each of the companies to the Institute for this purpose is 150*l*. a year. Copies of the schemes under which the Fellowships will be awarded may be had on application to the Honorary Secretary of the Institute, Gresham College, Hasinghall Street, London, E. C.

Mr. Mark W. Harrington will return to his professional work, and would accept a call to a chair of astronomy or mathematics. He could not fail to build up a good department in any of the lines coming under these heads—as in polytechnic schools, or in universities, or in colleges, where new developments in the direction of an observatory or a branch of engineering are contemplated.

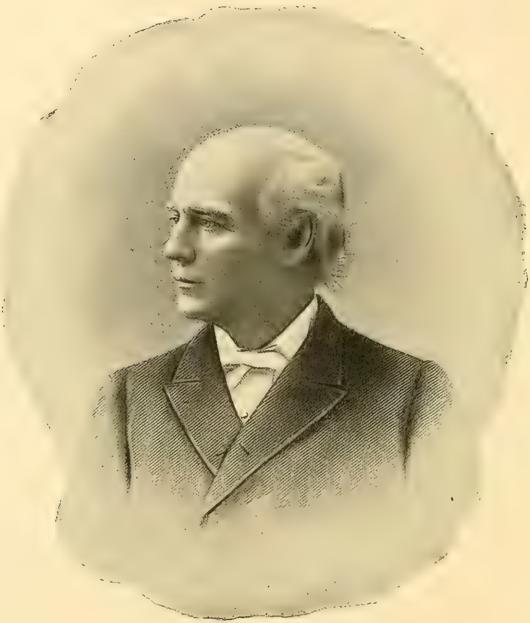
The following new appointments and promotions have been made in the French universities: M. Haller, professor at Nancy, to be professor of organic chemistry at Paris; M. Pellat, to be professor of physics at Paris; M. Chatin, to be professor of histology at Paris; M. Cannien to be professor of anatomy at Bordeaux; M. Künstler to be professor of comparative anatomy and embryology at Bordeaux; M. Picart to be professor of astronomy at Lille; M. Ardaillon to be professor of geography at Lille; M. Guitel to be adjunct professor of zoology at Rennes.

Professor v. Frey has been called to the professorship of physiology at Würzberg.

Dr. Hans Battermann, Observer in the Observatory at Berlin, has been promoted to a professorship.

The following have qualified for docents in the German universities: Dr. Somner for physiology in Würzburg, Dr. Schwarzschild for astronomy in Munich, and Dr. Stolle for chemistry in Heidelberg.

Dr. A. C. Houston has been appointed lecturer in bacteriology at Bedford College, London.



Edward Orton

President of the American Association for the Advancement of Science.

SCIENCE

FRIDAY, SEPTEMBER 1, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE second half century in the history of the American Association was begun worthily last week at Columbus. It might have been feared that a meeting following the celebration of the fiftieth anniversary at Boston and held at some distance from the Atlantic seaboard would witness a small attendance and perhaps a lack of interest. This was by no means the case. The attendance was larger than at Detroit, Buffalo, Madison and Cleveland, and about the same as at Springfield, Indianapolis and Ann Arbor, while it was the unanimous opinion of those present that the meeting was in every respect profitable and enjoyable.

It seems evident that the Association has now entered upon a new era. In the course of fifty years the environment has altered greatly and for a little while there seemed to be some danger lest the Association might fail to adjust itself to the new condi-

tions. The missionary and social aspects of its work have become somewhat less important, while specialization in science seemed to give a heterogeneity that threatened to break up the parent Association into numerous special societies. But the Columbus meeting confronted any such theory with the unanswerable argument of success. The entertainment was admirably arranged so as to provide social intercourse without interfering with the scientific work of the sections, while in turn the meeting will assist the Ohio State University in the great career upon which it has entered. The affiliation of nine separate societies, either by amalgamation with the sections or by simultaneous meetings, proves that the specialization demanded by modern science may, in fact, contribute to the weight and authority of the Association representing science in America.

The organization of the Association and of the separate sections has in the past been somewhat amorphous. A council with no real powers, consisting chiefly of past Presidents usually absent and officers newly elected without special reference to their functions as councillors, could scarcely be expected to decide upon or to continue a definite policy. But at Boston amendments to the constitution were incorporated, giving the council authority to decide important questions and making it a truly representative and deliberative body. At Columbus further amendments were adopted assuring the presence of vice-presidents for two consecutive meetings and making them members of the council for three years. This action will also strengthen the sectional committees by giving them at least one member who has had some experience. We urge that Vice-Presidents should be members of the sectional committees for at least three years, as they now are of the council, and trust that an amendment to this effect may be introduced next year. On the other hand, it would probably be desirable for the secretaries of the sections to be members of the council only for the year in which they hold office.

The improvement in the deliberations of the council at Columbus was very evident. All business was transacted promptly, and wisely, without undue haste or undue delay. The council made the important decisions entrusted to it with a sense of its responsibility, and the amendments to the constitution recommended to the general session were adopted without dissent. The proposal to meet in New York next year was quite unexpected, it being supposed that either Denver or Philadelphia would be chosen. No formal invitations had been prepared, and it was expressly stated that the members from New York did not regard that city as a suitable place for public or private hospitality. A radical change in the time of the meeting was also proposed. Yet the council was able to consider these propositions on their merits and to come to a practically unanimous decision.

The wisdom of this decision cannot be questioned. After the meeting in Ohio precedent pointed to one of the great Eastern cities for the following year, where a large attendance could be expected. It is equally desirable to hold soon a meeting further towards the West than hitherto, and the recommendation to accept the cordial Denver invitation for 1901 sets a good pre-

cedent in designating a place for meeting well in advance. A week for the meeting immediately following the close of the colleges in June has much to recommend it. It does not break into summer expeditions, summer work and summer vacations as does a week in August, and the weather is likely to be favorable. New York City and the last week in June will be especially convenient next year for the large number of scientific men who at about that time will leave New York to attend the scientific congresses of the Paris Exposition.

The New York members do not propose to arrange for a welcome by the Mayor or his representative from Tammany Hall; they do not think that the Association can do much missionary work in the city or that the city can offer them entertainments and excursions, but they believe that they can make good arrangements for the scientific work of the sections and of the affiliated societies and can welcome the Association to a city that has made unusual scientific advances since the New York meeting of 1887. During these few years Columbia and New York have become great universities whose development is fittingly represented on new sites by magnificent libraries and laboratories; the American Museum of Natural History has perhaps quadrupled its buildings and collections; a museum of art and antiquities unsurpassed in America has been erected; a great public library has been founded and its building is in course of construction; an aquarium has been formed, and a botanical garden and a zoological park have been established that are preparing to rival the similar institutions of the great European cities.

Next year for the first time a place in the Association will be provided for students of physiology and experimental medicine, and for the first time the American Mathematical Society; the Society for the Promotion of Engineering Education and probably other societies will meet as part of the Association; the address of the retiring President will be made by a man honored and beloved of all; the meeting will be presided over by a leading man of science, whose services to the Association have been preëminent, and the arrangements will be made by a Permanent Secretary who has already proved his wisdom and ability. It is certain that there will be next year in New York an excellent meeting, and that it will be followed by a series of meetings that will make greatly for the advancement of science in America.

ADDRESS OF WELCOME.

Dr. W. O. Thompson, President of the Ohio State University, said: It is a genuine pleasure to stand here this morning in the name of the Ohio State University, and extend a hearty welcome to the American Association for the Advancement of Science. We welcome you to our grounds, our buildings and our hearts. We pledge you now our utmost endeavor to make your stay as pleasant as we expect the meetings to be profitable.

There is no place on the continent where a company of men devoted to the study of science could be more welcome than at a State university. They are the peoples' institutions and have devoted their strength and energy to preparing young men and women for active participation in the rapidly growing civilization about us.

I need not remind you that the great Ordinance of 1787 was the beginning of public

education in the Northwest Territory. That ordinance provided for the support of education by generous grants of land. Out of this the public school system rapidly grew. The development of the public schools made possible the growth of the State university.

Nor need I remind you that the most characteristic feature of education in the last twenty-five years has been the growth and development of the State universities in this great territory. Nor need I remind you that to the west of us may be found a number of State universities older and better equipped and with a larger teaching force than the one with which you are now meeting. Ohio was the first State carved out of the Northwest Territory, but practically the last to develop her university.

To the west you may think of Indiana, Illinois, Michigan, Wisconsin, Minnesota, Nebraska, Kansas, Missouri, Colorado and others. You are meeting to-day at the gateway to these great educational centers. The Ohio State University is exceedingly happy in the privilege of extending a welcome to you, not only in her own name, but in the name of all these institutions which are to do so much in the future for industrial and scientific education in the Great West. We recognize in this Association a body of men devoted to the study of science and scientific education. We trust that your stay with us will assure you that the Ohio State University proposes to prove her right to existence by ministering to the needs of the people, and by presenting to them an open opportunity to the best that modern education can supply.

Let me assure you of a very cordial welcome and of our best wishes for a successful meeting.

ADDRESS OF THE PRESIDENT.

DR. EDWARD ORTON said: In behalf of the American Association for the Advancement of Science I return to you our cordial thanks for the welcome which you have this day given us to the capital of Ohio. We note with pleasure all that you say of the State and the City. We are sure that you have not exaggerated the charms of this noble section of the Mississippi Valley, which, all things considered, its location, its climate, its agricultural and its mineral resources, we take to be as the great Frenchman, De Tocqueville, declared, three-quarters of a century ago, the noblest dwelling place that God has fitted up for the occupation of the human race.

The principal office of such a reception as this is, I take it, to set both parties at their ease, to put host and guest on good terms with each other. You have spoken for the host and we accept all that you claim for the city and the State at its face value. We count ourselves happy to be here. We are glad to enjoy for a few days your hospitality. We hope and expect that the Columbus meeting of the Association will prove a memorable one, one that will shine in our annals, if not by the announcement of great discoveries in the heavens or earth, still by the inspiration it will give to multitudes of workers in the several fields of science.

And now let me say a word for the guests on this occasion. I shall ask you to accept, without any discount, all that we shall say about ourselves, all that we claim for our work, in the same generous spirit that we have already manifested toward you. People come to be on good terms with each other more easily, perhaps, if they are first on good terms with themselves. As our hosts you have shown a good measure of self-complacency, and you will not expect us to fall behind in this virtue. Well, then, I may say for the American Association for the Advancement of Science that it is well worthy of the hospitality which you proffer. It deserves all the honor that Columbus or any other community of the

country can pay it. No organization ever visits an American city that has a better claim on the appreciation and respect of all its people.

In the first place, you can hardly expect to entertain an organization of larger range, so far at least as its name is concerned. It is the American Association. It transcends not only all State limits, but national boundaries as well. An organization that represents the United States takes in a respectable part of the land areas of the planet, but this is not merely a United States organization. It especially includes that potent and ambitious neighbor of ours to the northward that owns more than three million square miles, or a full half, of the North American continent. The Association always counts with all confidence on its Canadian contingent. You can hear this afternoon an address from the honorable Canadian Vice-President of one of our sections, Mr. Whiteaves, of Ottawa.

Our name is broad enough to include also our neighbors to the southward, Mexico and the Central American republics, but these countries have thus far devoted so much of their time and force to military science in the practical way that they have not had much enthusiasm left for the cultivation of the other branches of science in which our Association is especially interested.

But there are American associations and American associations. They are not all alike. They are devoted to various interests. Some of them, in spite of the broad name they bear, have but a comparatively narrow field.

For example, there is an American Numismatic Society, an American Stockbreeders' Association, an American Strawboard Company, an American Detective Agency, etc., but this is the American Association for the Advancement of Science. As I have said, no organization can well have a broader geographical name, and when we come to its subject-matter, the field in which it works, certainly no organization can claim wider interest or greater importance.

The American Association for the Advancement of Science! Have you considered what this name implies? We are coming to the close of the nineteenth century, which has been well styled the century of science.

Alfred R. Wallace has recently published a careful inventory of the discoveries and inventions to which the progress of the race is mainly due, and he divides them into two groups, the first embracing all the epoch-making advances achieved by man previous to the present century, and the second taking in the discoveries and advances of equal value that have had their origin in the nineteenth century. In the first list he finds but fifteen items of the highest rank, and the claims of some even of this number to a separate place are not beyond question. They may not really be of epoch-making character. But he puts into the list the following, viz: Alphabetic writing and the Arabic notation, which have always been the two great engines of knowledge and discovery. Their inventors are unknown, lost in the dim twilight of pre-historic times. Coming after a vast interval to the fourteenth century A. D. we find the mariner's compass, and in the fifteenth the printing press, both of which, beyond question, are of the same character and rank as alphabetic writing. From the sixteenth century we get no physical invention or discovery, but it witnessed an amazing movement of the human mind, which in good time gave rise to the great catalogue of advances of the seventeenth century, the most prolific of all the centuries antecedent to our own. To it we credit the invention of the telescope and, though not of equal rank, the barometer and thermometer, and in still another field the invention of the

differential calculus, the all-important discovery of gravitation, of the laws of planetary motion, of the circulation of the blood, of the measurement of the velocity of light. To the eighteenth century we refer the more important of the earlier steps in the evolution of the steam engine and the foundation of both modern chemistry and electrical science. This completes the list. Counting all these inventions and discoveries as separate we get sixteen. Wallace places the barometer and thermometer under one number and thus makes a total of fifteen.

What is there to be added to this list? Some would urge that Jenner's discovery should be included here, but this claim Wallace would indignantly deny.

In making such a list it is evident that the personal equation of the author needs to be recognized, and different orders of arrangement, even if the elements were the same, would be assigned by different students. At any rate, something like this is the list of what the race has gained in science since it first came to itself, up to the year 1800. The greatest steps have certainly all been counted.

And now what has the record been since 1800? How does the 19th century compare with its predecessors? A brief examination will show that in scientific discovery and progress it is not to be compared with any single century, but rather with all past time. In fact, it far outweighs the entire progress of the race from the beginning up to 1800. Counting on the same basis as that which he had previously adopted, Wallace finds 24 discoveries and inventions of the first-class that have had their origin in the 19th century, against the 15 or 16, already enumerated of all past time. This is not a proper occasion to review, compare and set in order the several elements of this glorious list, but let me simply recall to your minds a few of them.

Of the same rank with Newton's theory of gravitation, which comes from the 17th century, stands out the doctrine of the correlation and conservation of forces of our own century, certainly one of the widest and most far-reaching generalizations that the mind of man has yet reached. Against Kepler's laws from the 17th century we can set the nebular theory of the 19th. The telescope of the 17th is overbalanced by the spectroscope of the 19th. If the first reveals to us myriads of suns, otherwise unseen, scattered through the illimitable fields of space, the second tells us what substances compose these suns and maintain their distant fires and, most wonderful of all, the state in which each exists, whether solid or gaseous, and the direction and the rate in which each is moving. Of the 56 stars whose motion in the line of sight have thus far been determined five were determined in the Emerson McMillin Observatory.

Harvey's immortal discovery of the 17th century finds a full equivalent in the germ theory of diseases of the 19th. The mariner's compass of the 14th century easily yields first place to the electric telegraph of the 19th, while the barometer and thermometer of the 17th century are certainly less wonderful, though, perhaps, not less serviceable, than the telephone and phonograph and Röntgen rays of our own day.

I need not pursue the comparison exhaustively, but, in addition to the advances now enumerated, the great doctrine of Organic Evolution, supported especially by the recapitulation theory in embryology, finds nothing to match with it in broadening and inspiring power, in all the past history of the race. The same can be said of the periodic law of Mendeljeff in chemistry, of the molecular theory of gases, of Lord Kelvin's vortex theory of matter, of the glacial period in geology, and of the establishment of the origin and antiquity of man, all of our own century.

Nothing can be brought from all the past

to compare for one moment in direct application to the relief of man's estate with the discovery of anæsthetics, while by his discovery of antiseptic surgery the name and fame of Lord Lister will grow to the last syllable of recorded time. In the mobilization of man and the giving to him the freedom of the globe, the railways and the steamships of our century are absolutely without any elements for comparison in all that the past has left us.

There are, however, three inventions and discoveries that have been inherited from the past and that have been already named, two of them from some distant but unrecorded centuries and one from the darkness of the Middle Ages, which have proved so indispensable to all subsequent advances that it is impossible for even the 19th century to present anything that can be properly compared with them. I refer to the alphabet, Arabic numerals and the printing press. To this list might perhaps be added language and the use of fire. The factors I have named are pre-supposed in all modern progress. By the very necessities of the case they must have preceded the progress at which we have glanced.

As I have before said, the 19th century is the century of science, and it is science, mainly physical science, that constitutes the proper object of this Association. Our geographical name is wide, but the scope of our Association is wider still. It deals with and is devoted to science, which is the product of the best powers of the human mind —the human mind, created in the image of God and divinely inspired to interpret this wonderful universe.

This Association marks the stage already reached in this interpretation, but in its very title it indicates that the work is incomplete, that it is still in progress. Its founders, fifty years ago, clearly saw that they were in the early morning of a growing day. The most unexpected and marvelous progress has been made since that date, but as yet there is no occasion and no prospect of modifying the title. We are still laboring for the advancement of science, for the discovery of new truth. The field, which is the world, was never so white unto the harvest as now, but it is still early morning on the dial of science.

It is possible that we could make ourselves more interesting to the general public if we occasionally foreswore our loyalty to our name and spent a portion of our time in re-stating established truths. Our contributions to the advancement of science are often fragmentary and devoid of special interest to the outside world. But every one of them has a place in the great temple of knowledge and the wise master builders, some of whom appear in every generation, will find them all and use them all at last,and then only will their true value come to light.

We do not always know the real significance of what we have in hand. A fact or an observation that we may put on record here may have in reality a different significance from what we are disposed to give it, and consequently may have far more importance than we recognize.

We welcome our hosts to our meetings and our discussions. We cannot promise that all will be found interesting, but occasionally conflicting views will give rise to animated debate in which human nature sometimes asserts itself so strongly and naturally that the debate would prove interesting to the outsider even though it may be carried on in what is practically a foreign tongue.

Thanking you again for your words of welcome and gratefully recognizing the arduous and efficient labors of the several committees of the gentlemen and ladies of Columbus in providing for our entertainment, I now declare the forty-eighth meeting of the American Association for the Advancement of Science open for the transaction of its appropriate business.

PROCEEDINGS OF THE ASSOCIATION.

THE forty-eighth annual meeting was held at Columbus, Ohio, from August 19th to 26th. There were 352 members and asciates in attendance and 273 papers were presented before the sections. Twenty-eight States, the District of Columbia and Canada were represented as follows: Ohio, 113; New York, 52: District of Columbia, 25; Pennsylvania, 21; Massachusetts, 18; Indiana and Michigan, 12 each; Iowa and Illinois, 9 each; Kentucky, 7; Canada, Connecticut, Kansas, New Hampshire, Nebraska and Wisconsin, 6 each; Minnesota, Texas and Maryland, 5 each; Missouri and Virginia, 4 each; West Virginia and North Carolina, 3 each; New Jersey and Colorado, 2 each; Alabama, Rhode Island, Washington and Louisiana, 1 each.

The papers were distributed among the sections as follows: Fourteen before Section 'A' (including five reports of progress); forty before Section 'B'; fifty-five before Section 'C'; fifteen before Section 'D'; thirty-three before Section 'E'; nineteen before Section 'F'; thirty-three before Section 'G'; twenty-seven before the Botanical Club of the Association; twenty before Section 'H,' and seventeen before Section 'I.'

The first general session was called to order at 10 o'clock on Monday morning by the retiring President, Professor Frederic W. Putnam, of Harvard University, who with a few remarks introduced the President-elect, Dr. Edward Orton, of Ohio State University. Dr. Orton took the chair and introduced General Axline, who welcomed the Association on behalf of the State of Ohio, and was followed by Judge M. B. Earnhart, representing the city of Columbus. Dr. William O. Thompson, President of the Ohio State University, then spoke on behalf of the University, and President Orton replied for the Association. The addresses of Dr. Thompson and of President Orton are given in full in this issue of SCIENCE.

A resolution by the Council was then read by the General Secretary, extending the privileges of associate membership to the members of the Local Committee, to citizens of Columbus and the immediate vicinity interested in scientific work, and to members of the affilliated societies meeting with the Association.

In accordance with custom the Permanent Secretary read the names of members and fellows of the Association deceased since the Boston meeting. Among these were the names of two honored past presidents of the Association, Professor O. C. Marsh, of Yale University, and Professor Daniel G. Brinton, of the University of Pennsylvania.

The Local Secretary, Professor B. F. Thomas, representing the Local Committee, then made announcement of the arrangements for the reception and entertainment of the Association. In addition to luncheons provided in one of the University buildings, the receptions given by President and Mrs. Thompson and by the Columbus Club, and the several entertainments provided for the ladies, the members of the Association were invited to join excursions to the gas fields near Lancaster, to the coal fields of the Hocking Valley, to the prehistoric fortifications at Fort Ancient, and to the islands in Lake Erie. The latter excursions were on Saturday and consequently did not interrupt the serious work of the sections. On Monday a more extended excursion was arranged to Mackinac and the Great Lakes. The excursions and entertainments were largely attended, and the resolutions of thanks presented by President Mendenhall at the close of the meeting were seconded and carried with unusual cordiality.

On Monday afternoon the addresses of the Vice-Presidents were delivered as follows:

At Two o'clock.

Vice-President BENJAMIN, before Section of Social and Economic Science. Subject: 'The Past Presidents of the Associations.'

Vice-President WHITEAVES, before Section of Geology and Geography. Subject: 'The Devonian in Canada.'

Vice-President THOMSON, before Section of Physics. Subject: 'The Field of Experimental Research.'

At Three o'clock.

Vice-President MACFARLANE, before Section of Mathematics and Astronomy. Subject: 'The Fundamental Principles of Algebra.'

Vice-President BULL, before Section of Mechanical Science and Engineering. Subject: 'Engineering Education as a Preliminary Training for Scientific Research Work.'

Vice-President GAGE, before Section of Zoology. Subject: 'The Importance and the Promise in the Study of the Domestic Animals.'

At Four o'clock.

Vice-President VENABLE, before Section of Chemistry. Subject: 'Definition of the Element.'

Vice-President BARNES, before Section of Botany. Subject: 'The Progress and Problems of Plant Phys iology.'

Vice-President WILSON, before Section of Anthropology. Subject: 'Beginnings of the Science of Prehistoric Anthropology.'

These addresses are in course of publication in SCIENCE, while in the issue for last week will be found the address of the retiring President, Professor Putnam, on 'A Problem in American Anthropology,' delivered on Monday evening. On Wednesday evening Professor C. E. Munroe, of the Columbian University, gave the lecture complimentary to the citizens of Columbus, his subject being 'Applications of Modern Explosives.'

Among the items of executive business we may note that authority was given to officers of the Association whereby any section may arrange for a joint meeting with an independent society of similar scope. Section H was authorized to hold its usual winter meeting. The report of the Treasurer and Permanent Secretary showed a gratifying increase in the funds of the Association. In addition to income derived from investments, the Permanent Secretary was able to turn over to the Treasurer, to be added to the permanent fund, $1,000 derived from membership fees.

President Orton announced the gift of $1,000 from Mr. Emerson McMillin, well known for his generous benefactions to science. Thereupon Mr. McMillin was elected a patron of the Association.

The amendments to the constitution, acted upon by the Council and presented to the Association at the Boston meeting and already printed, were adopted. New amendments to the Constitution were proposed by Dr. McGee, making the term of office of the Treasurer five years and by Dr. Cattell adding a Section of Physiology and Experimental Medicine.

The Committee on the White Race in America made a report and was given a grant of $50 for the establishment of an anthropometric laboratory at the next meeting of the Association. A second grant of $50 was made for the quantitative study of biological variation under Dr. Davenport, and to report and extend this work a committee was appointed, consisting of Drs. Boas, Cattell, Minot, Eigenmann and Davenport. The only other grant made for research was one of $100 for the purpose of stocking pools with different species of blind vertebrates where they may be reared and studied in the light, the work being carried out by Professor Eigenmann.

Reports were also made by the committees on the library, on standards of measurement and on the U. S. Naval Observatory. Several committees that had accomplished the work for which they had been appointed were discharged.

The officers nominated for 1900 are as follows:

President—R. S. Woodward, Columbia University.

Vice-Presidents—Section A, mathematics and astronomy, Asaph Hall, Jr., University of Michigan;

section B, physics, Ernest Merritt, Cornell University; section C, chemistry, James Lewis Howe, Washington and Lee University ; section D, mechanical science and engineering, J. A. Brashear, of Pittsburg, Pa.; section E, geology and geography, J. F. Kemp, Columbia University ; section F, zoology, C. B. Davenport, Harvard University ; section G, botany, W. Trelease, Missouri Botanical Garden ; section H, anthropology, A. W. Butler, of Indianapolis ; section I, economic science and statistics, C. M. Woodward, Washington University.

Permanent Secretary—L. O. Howard, United States Entomologist, of Washington.

General Secretary—Charles Baskerville, the University of North Carolina.

Secretary of the Council—William Hallock, Columbia University.

Secretaries of Sections—Section A, W. M. Strong, Yale University ; section B, R. A. Fessenden, of Allegheny, Pa.; section C, A. A. Noyes, Massachusetts Institute of Technology ; section D, W. T. Magruder, Ohio State University ; section E, J. A. Holmes, University of North Carolina ; section F, C. H. Eigenmann, University of Indiana ; section G, D. T. Macdougal, New York Botanical Garden ; section H, Frank Russell, Harvard University ; section I, H. T. Newcombe, of Washington.

Treasurer—R. S. Woodward, Columbia University.

FREDERICK BEDELL,
General Secretary.

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*THE DEFINITION OF THE ELEMENT.**

IT is with hesitation that I enter upon so speculative a discussion as the nature of the elements, and yet there are reasons why it should prove of great profit to draw the attention of this representative gathering of the chemists of America to this subject. We have nearly reached the close of the first century in which these elements have been the subject of experimental research. The ingenuity and the patient labor of an army of workers have been directed at the solution of the many problems connected with these elementary substances, and the ultimate aim, the goal, of all their striving has been the discovery of the properties and the nature of the atom.

It is eminently fitting that, as we stand at the threshold of the new century, we glance back along the road we have already come and take some account of the progress we have made. The quicksands of mere speculation must be avoided, and yet the mental vision, the 'scientific imagination,' must be called into service in considering that which so far transcends our cruder actual vision as the incomparable atom itself. There is another reason for considering the nature of the elements. At several times during the century a wider vision has made it necessary to recast the definition of the elements to accord with increasing knowledge. It would seem as if another such period of change were approaching. There may be need of a truer definition, and how shall this be realized or the new definition properly fitted unless the knowledge gained be summed up and appreciated ?

The conception of an element among the Greek philosophers and the earlier alchemists was very different from the modern idea. This conception sprang from the theories as to the formation of the material universe. The elements were the primal forms of matter seen only combined, impure, imperfect. They were the essences or principles out of which all things were evolved. In the four-element theory, which was so widely spread among the ancients, the fire, air, earth and water were not the ordinary substances known under these names, but the pure essences bestowing upon fire and water their peculiar properties. These essences were not thought of as actual substances capable of a separate material existence, and gradually the belief that a transmutation was possible between them sprang up. Thus they themselves might be derived from some one of

* Address of the Vice-President before Section C—Chemistry—of the American Association for the Advancement of Science, at the Columbus meeting, August, 1899.

them, as fire or water. The Thalesian theory deriving all things from water was especially popular and was not completely overthrown until the modern era.

When, later on, the alchemist conceived of all metals as composed of sulphur and mercury it was an essence or spirit of mercury that was meant. Certain common characteristics as luster, malleability, fusibility, combustibility, etc., naturally led them to think of the metals as belonging to the same order of substances containing the same principles, the relative proportions and purity of which determined the variations in the observed properties. Thus the properties of the metals depended upon the purity of the mercury and sulphur in them, the quantities of them and their degree of fixation. The more easily a metal was oxidized on being heated, the more sulphur it contained, and this sulphur also determined its changeability. The more malleable it was, the more mercury entered into its composition. If only something could be found which would remove the grossness from these essences, some unchanging, all-powerful essence, which, because of their search for it, gradually became known as the 'philosophers' stone,' then the baser metals might be transmuted into the noble gold when the sulphur and mercury were perfectly balanced and free from all distempers.

As has been said, these principles entering, all or some of them, into every known substance, were supposed to be not necessarily capable of individual existence themselves. This was the view held by the followers of Aristotle. With the reaction against the domination of the scholiasts, other views began to be held. It was Boyle who first gave voice to these changed views in his 'Sceptical Chemist' (1661). He defined elements as "certain primitive bodies, which, not being made of any other bodies, or of one another, are the ingredients of which all those called perfectly mixed bodies are immediately compounded, and into which they are ultimately resolved." He, however, did not believe himself warranted, from the knowledge then possessed, in claiming the positive existence of such elements.

But little attention was paid to the subject by the subsequent chemists. The phlogistics were too much occupied with their theory of combustion, and none could see the bearing of this question and its importance to exact science.

Macquer, in his 'Dictionary of Chemistry' (1777), words his definition as follows: "Those bodies are called elements which are so simple that they cannot by any known means be decomposed or even altered and which also enter as principles or constituent parts into the combination of other bodies." To this he adds: "The bodies in which this simplicity has been observed are fire, air and the purest earth." In all of this may be observed the resolution of observed forms of matter into primal principles following the dream of Lucretius and the early Epicurean philosophers, a dream abandoned by the atomic school following, though largely holding to the same definition.

It was only when chemists began to realize that mere observation of properties, chiefly physical, was not sufficient that the subject began to clear up and lose its vagueness. Black proved that certain substances were possessed of a constant and definite composition and fixed properties, unalterable and hence simple bodies or elements. Lavoisier finally cleared the way for the work of the nineteenth century by his definition that "an element is a substance from which no simpler body has yet been obtained; a body in which no change causes a diminution of weight. Every substance is to be regarded as an element until it is proved to be otherwise." With this clear

definition to build upon, a rational system of chemistry became, for the first time, a possibility.

Thus the elements were recognized as simple bodies because there were no simpler. They were not complex or compound. The distinction was clearly drawn between bodies simple and bodies compound, and the name simple body has been frequently used as a synonym for element through a large part of this century. Naturally the question of simplicity was first settled by an appeal to that great arbiter of chemical questions, the balance. And, quite as naturally, many blunders were made and the list of bodies erroneously supposed to be simple was very large. All whose weight could not be reduced were considered elementary. When, however, from such a body, something of lesser weight could be produced, its supposed simplicity was, of course, disproved.

This test for the elemental character has been clung to persistently, and is perhaps still taught, although it was long ago recognized that many of the elements existed in different forms, a phenomenon to which Berzelius gave the name *allotropism*. One only of these could be simplest, and the others could be reduced to this one and rendered specifically lighter. With the discovery of this relation it should have been quite apparent that the old definition would no longer hold good. But many years passed before chemists were made to feel that a new definition was necessary, and adapted one to the newer knowledge.

The insight into what Lucretius would call 'the nature of things' was becoming clearer; the mental grasp upon these elusive atoms about which the old Epicurean reasoned so shrewdly was becoming firmer. Through what one must regard as the veil interposed by the earlier idea of the element, the chemist began to grope after the constituent particle or atom. It must be borne in mind that the definition of the element was largely formulated before the resuscitation of the atomic theory by Dalton, and the mental picture of the one has perhaps retarded the clearing up of the ideas concerning the other. From the atomic point of view the element was next defined as one in which the molecules or divisible parts were made up of similar indivisible particles. This afforded an easy explanation of allotropism as a change in the number of atoms in a molecule. As Remsen says: "An element is a substance made up of atoms of the same kind; a compound is a substance made up of elements of unlike kind."

Laying aside, then, all vaguely formulated ideas of essences, or principles, or simple bodies, or elemental forms, we found our present building upon the conception of the ultimate particle, be this molecule or atom.

As to this atom some clear conception is needed, and here we come to the *crux* of the modern theories. The chemist regards this atom as a particle of matter and is unwilling to accept the theory of Boscovich that it is infinitely small, and hence a mathematical point, nor can he admit that it is merely a resisting point, and hence that all matter is but a system of forces. And yet it seems as though some authorities would lead up to such a conclusion.

While we need not consider these atoms as mere centers of forces, we are compelled to study them by the operation of forces upon them. What are called their properties have been studied and recorded with great care. These properties are evinced in the action of the forces upon matter, and the exhibition of force without matter cannot be admitted. This study of the properties has been the especial occupation of the century now closing, and so the elemental atom has come to be regarded as a collection of properties. As Patterson-Muir puts it (Alchemical Essence and the

Chemical Elements, p. 31): "The name copper is used to distinguish a certain group of properties, that we always find associated together, from other groups of associated properties, and if we do not find the group of properties connoted by the term copper we do not find copper."

These properties are exhibited by the action of a small group of forces. Perhaps we do not know all of the forces; certain it is that we do not accurately know all of the properties, but, to quote Patterson-Muir again: "The discovery of new properties always associated with a group of properties we call copper would not invalidate the statement that copper is always copper."

The properties of an atom are either primary, inherent and as unchanging as the atom itself, or they are secondary and dependent upon the influence of the other atoms, or varying with the change of conditions. To the first class belong such properties as the atomic weight, atomic heat, specific gravity, etc.; to the second, chemical affinity, valence, etc. In all the study of the atom the distinction between these should be carefully maintained in order that there may be clear thinking.

There is no field of mental activity requiring more faith than that of the chemist. He is dealing with the 'evidences of things unseen.' He must not be content with the mere gathering of facts, but divine what he can of their deeper meaning. Few chemists have had such insight as Graham into the significance of even the simplest changes. He was not content with mere surface observation. Even the commonest observed phenomena were to him full of meaning as to the atoms and their 'eternal motion.' Thorpe (Essays in Historical Chemistry, p. 219) has drawn afresh the attention of the chemists to the thoughtful words of this great thinker. His mind was filled with the fascinating dream of the unity of matter. "In all his work," says Adam Smith, "we find him steadily thinking on the ultimate composition of bodies. He searches after it in following the molecules of gases when diffusing; these he watches as they flow into a vacuum or into other gases, and observes carefully as they pass through tubes, noting the effect of weight, of composition, upon them in transpiration. He follows them as they enter into liquids and pass out, and as they are absorbed or dissolved by colloid bodies; he attentively inquires if they are absorbed by metals in a similar manner, and finds remotest analogies which, by their boldness, compel one to stop reading and to think if they really be possible."

In his paper entitled 'Speculative Ideas respecting the Constitution of Matter,' published in the Proceedings of the Royal Society in 1863, which Thorpe calls his 'Confession of Faith,' he tells of his conception that these supposed elements of ours may possess one and the same ultimate or atomic molecule existing in different conditions of movement.

It is not possible for me, in the limits of this address, to array before you all of the various evidence which leads to the belief that our so-called elementary atoms are after all but compounds of an intimate, peculiar nature whose dissociation we have as yet been unable to accomplish. When properly marshalled, it gives a very staggering blow to the old faith. Thorpe speaks of the "old metaphysical quibble concerning the divisibility or indivisibility of the atom." To Graham "the atom meant something which is not divided, not something which cannot be divided." The original indivisible atom may be something far down in the make-up of the molecule.

How shall the question as to the composite nature of the elements be approached? The problem has been attacked from the experimental side several times during the last half century, but the work

seems to have been carried on after a desultory fashion and was soon dropped, as if the workers were convinced of its uselessness. The results, being negative, simply serve to show that no method was hit upon for decomposing the elements upon which the experiments were performed. Thus, for instance, Despretz performed a number of experiments to combat Dumas' views as to the composite nature of the elements. Despretz made use of the well-known laboratory methods for the separation and purification of substances. Such were distillation, electrolysis, fractional precipitation, etc. Such work was quite inadequate to settle the question, as Dumas had pointed out that unusual methods must be used, or, he might have added, the old methods carried out to an unusual or exhaustive extent. Certainly, if a moderate application of the usual methods was sufficient for this decomposition, evidences of it would have been obtained long ago by the host of careful workers who have occupied themselves over these substances. Crookes has busied himself with the method of fractional precipitation (though not with special view to the testing of this question), and applied it most patiently and exhaustively to such substances as the rare earths, without obtaining results from which anything conclusive could be drawn. Victor Meyer seems to have believed that the decomposition could be effected by high temperatures, and was very hopeful of experiments which he had planned before his untimely death. Others have spasmodically given a little time to the problem, but no one has thought highly enough of it to attack it with all of his energy.

Let us stop a moment and ask ourselves what would be attained if any one should succeed in decomposing an element by one of the usual methods. Has not this been done repeatedly in the past and merely served to add to the list of the elements? Didymium has been made to yield praseo and neodymium. That which was first called yttrium has been divided into erbium, terbium and ytterbium, and according to Crookes may possibly be still further decomposed. But these and similar decompositions are not generally accepted as offering any evidence that elements can be decomposed. It is merely the discovery of one or more new substances which have remained hidden in constant association with known bodies which were supposed to be simple. It would be necessary to prove that a single individual element had, by the process adopted, been actually decomposed and not some pre-existing impurity discovered. This, of course, would be exceedingly difficult, and all such attempts as those mentioned can have little bearing upon the general question, and can hold out slight hope of reward beyond the fame springing from the discovery of a new element.

Successful decomposition should mean much more. It should mean the discovery of a method which will decompose not one, but many or indeed, all of the elements, and the decomposition of these must not yield a larger number of supposedly simple bodies, but a small group of one or two or three which are common constituents of all. It is quite idle to venture upon any prediction whether such a method will ever be discovered. Setting aside, then, the direct experimental proof of the composite nature of the elements as unattainable at present, let us next examine the indirect evidence. It would seem wisest for the present to introduce under that heading the spectroscopic work of Lockyer. The results, while highly interesting, are too indefinite as yet to speak of as having a direct bearing. Yet a careful study of the spectra of the elements leads us to a strong suspicion that the less plausible assumption is the one that the particles which give rise to such varied

vibrations are simple and unitary in nature. Lockyer's most recent work, following up the line of his 'Working Hypothesis' of twenty years ago, is very suggestive and may lead to important results (Chemistry of the Hottest Stars, Roy. Soc. Proc., LXI., 148 ; On the Order of Appearance of Chemical Substances at Different Temperatures, *Chem. News*, 79, 145). Still too much must be assumed yet for such work to be very conclusive. He writes of 'proto-magnesium and proto-calcium,' and Pickering discusses a 'new hydrogen,' all with an assurance and confidence which proves at least how deeply these changes in the spectra have impressed some of those who have most deeply studied them.

But a more important method of indirectly testing the question is through a comparison of the properties of the atoms. Such a comparison has been made as to the atomic weights. In other words, the idea of the composite nature of the elements followed very close upon the adoption of a stricter definition of them as simple bodies. Dalton, Prout, Döbereiner, Dumas, Cooke and many others have aided in developing the idea, sometimes faultily and harmfully, at other times helpfully. Some fell into the common error of going too far, but all were struck by the fact that when these combining numbers, or atomic weights, were compared strange and interesting symmetries appeared. The times were not ripe for an explanation of their meaning, and such crude assumptions as that of Prout, that the elements were composed of hydrogen, or that of Low, that they were made up of carbon and hydrogen, were too baseless to command much genuine support or to withstand much careful analysis. The important feature of agreement between such theories was the belief that the elements were composite and had one or more common constituents.

From the comparison of one property, the atomic weights, the next step was to the comparison of all the properties. This comparison is brought out clearest and best for us in the Periodic System. Here all the properties are very carefully tabulated for us. The study of the system leads indisputably to the conviction that this is not an arbitrary, but a natural arrangement, exceedingly simple in its groundwork, but embodying most fascinating symmetries, which hint of great underlying laws. He who looks upon it as a mere table of atomic weights has lost its meaning. It tells, with no uncertain note, of the kinship of the elements and leads to a search after the secret of this interdependence and of their common factor or factors. There is so much which is made clearer if we assume a composite nature for the elements that many do not hesitate to make the assumption.

Still another indirect method of approaching that problem is by analogy with bodies whose nature and composition are known. A very striking symmetry is observed between the hydrocarbons, and these in the form of compound radicals show a strong resemblance to certain of the elements. This analogy need not be dwelt upon here. It has been recognized for a long time and tables of hydrocarbons have been constructed after the manner of the Periodic System. Now these bodies are simply built up of carbon and hydrogen in varying proportions, and in any one homologous series the increments are regular. We know that they are composite and that they have but two common factors, carbon and hydrogen.

Again, the fact that certain groups of associated atoms behave as one element and closely resemble known elements may be taken as a clue to the nature of the elements. Thus carbon and nitrogen, in the form of cyanogen, behave very much like the halogens ; and nitrogen and hydrogen in the form of ammonia so closely resemble the group of elements known as the alkalies

that this "volatile alkali" was classed with them before the era of our elements and the analogy lead to a vain search for an "alkalizing principle" and later to an equally futile pursuit of the metal ammonium.

A further clue to this nature is afforded in the remarkable changes of properties which can be brought about in some elements by ordinary means, and one might mention the equally remarkable veiling of properties induced by the combining of two or more atoms. Thus copper exists in a cuprous and a cupric condition, and the change from one to the other can be readily brought about. And this is true of many other elements.

This has doubtless been a tedious enumeration to you of well-known facts and arguments, but it has been necessary, for I wish to lead you to the summing-up of these arguments and to induce you to draw boldly the necessary deductions. It is high time for chemists to formulate their opinions in this matter. It would seem as if we were shut up to one or two conclusions. Either these imagined simple bodies are after all compounds, built up of two or more common constituents, or they are but varying forms of one and the same kind of matter subjected to different influences and conditions. The supposition that they are distinct and unrelated simple bodies is, of course, a third alternative, but to my mind this is no longer tenable.

The second hypothesis is the one put forth by Graham. It was his cherished vision of the gaseous particles about which he thought so deeply, and in many was so truly. Thorpe has written of this as follows (loc. cit. 222):

"He conceives that the various kinds of matter, now recognized as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. Graham traces the harmony of this hypothesis of the essential unity of matter with the equal action of gravity upon all bodies. He recognizes that the numerous and varying properties of the solid and liquid, no less than the few grand and simple features of the gas, may all be dependent upon atomic and molecular mobility. Let us imagine, he says, one kind of substance only to exist—ponderable matter; and, further, that matter is divisible into ultimate atoms, uniform in size and weight. We shall have one substance and a common atom. With the atom at rest the uniformity of matter would be perfect. But the atom possesses always more or less motion, due, it must be assumed, to a primordial impulse. This motion gives rise to volume. The more rapid the movement, the greater the space occupied by the atom, somewhat as the orbit of a planet widens with the degree of projectile velocity. Matter is thus made to differ only in being lighter or denser matter. The specific motion of an atom being inalienable, light matter is no longer convertible into heavy matter. In short, matter of different density forms different substances — different inconvertible elements, as they have been considered."

The hypothesis that the elements are built up of two or more common constituents has a larger number of supporters and would seem more plausible. Some have supposed one such primal element by the condensation or polymerization of which the others were formed. Thus we have the hydrogen theory of Prout, modified to the one-half atom by Dumas, and finally by Zängerle to the one-thousandth hydrogen atom. The suggestion of Crookes as to the genesis of the elements from the hypothetical protyle, under the influence of electricity, may also be mentioned here.

Others have adopted the supposition of two elements, Reynolds making one of these an element with a negative atomic

weight, whatever that may mean. Low and others have fixed upon carbon and hydrogen as the two elements.

There are many practical difficulties in the way of these suppositions; the lack of uniformity in the differences between the atomic weights, the sudden change of electro-chemical character, and the impossibility, so far, of discovering any law underlying the gradation in the properties of the elements with the increase of atomic weights, are some of the difficulties. In comparing these two hypotheses that of Graham seems to me very improbable. I have thought of valence as dependent upon the character of the motion of the atom, but cannot well conceive of a similar dependence of atomic weight and all the other properties. There remains, then, the hypothesis of primal elements by the combination of which our elements have been formed. These molecules are probably distinguished from the ordinary molecules by the actual contact and absolute union of the component atoms without the intervention of ether.

Since these elemental molecules cannot as yet be divided, we may retain the name atom for them, but the idea of simplicity and homogeneity no longer belongs to them. The definition of an element as a body made up of similar atoms is equally lacking in fidelity to latest thought and belief, but chemists would scarcely consent to change it, and, indeed, it may well be retained, provided the modified meaning is given to the word atom. But, after all, an element is best defined by means of its properties. It is by close study of these that we decide upon its elemental nature, and through them it is tested. Complete reliance can no longer be placed upon the balance and the supposed atomic weight.

All elements are acted upon by gravity and chemical force and other physical forces, but within the last few years certain gaseous elements have been discovered which are not influenced by chemical force or affinity. According to some (Piccini, *Zeits. An. Chem.*, XIX, 295) this necessitates a division of the elements into two classes. Manifestly, since it is chiefly by the action of chemical force that we study the elements, the absence of such action cuts us off from our chief means of finding out anything about them, and it is equally clear that bodies so diverse cannot well be classified together. If all attempts at bringing about the chemical union of these gaseous elements with other bodies fail, I believe that we should insist upon the existence of two classes of elements and keep them distinct in all comparisons.

Of course, we are quite at a loss to say just what chemical force is, but it is believed to be determined by the electrical condition of the atom. Thus we have the elements which show the action of chemical affinity varying from strongly electro-positive to strongly negative. This electrical charge of the atom seems to be a primitive, inherent property, and so beyond our control or power to change. At least no change of the kind has ever been recognized and recorded. Sodium remains positive and chlorine negative in spite of all that may be done to them. We can, by uniting the two temporarily, cloak and neutralize their opposite natures, but the original condition returns on their release.

Is it not fair to assume that argon, helium and their companion gases, having no affinity, are without electrical charge—atoms from which the electrical charge has been withdrawn; the deadest forms of inanimate matter? Were they thus without electro-chemical properties and affinity from the beginning, or did they start out as ordinary atoms (if I may so call them), and somehow, somewhere lose these properties, and with them the power of entering into union of any kind, even of forming

molecules, doomed to unending single existence? Can these be changed atoms of some of our well-known elements, a step nearer to the primal elements and with the electrical charge lost? Is it possible for us to bring about these changes? May we not unwittingly have done so at some time or other in the past? Is it possible to restore the electrical charge to such atoms, and so to place them once more on a footing of equality with elements of the conventional type? These and many other questions surge through the mind as one thinks of these wonderful gases. Perhaps the coming century will unfold the answers.

F. P. Venable.

University of North Carolina.

*ENGINEERING EDUCATION AS A PRELIMINARY TRAINING FOR SCIENTIFIC RESEARCH WORK.**

At first thought it might seem that the subject chosen for this address is of such a nature that it should have been made the basis of a paper before the Society for the Promotion of Engineering Education. I admit that it would not have been out of place there, but at the same time I am of the opinion that such an address also forms, as it were, a bridge from our special engineering section to the purposes of the general Association. It will show that the work and the attainments of the engineer form an important and integral part of the scientific work of to-day.

As you no doubt know, there has been for some time general and strong misgivings as to the future of this section of the Association, and many have expressed the opinion that engineers and professors of engineering ought not to belong to the American Association for the Advancement of Science, as the work of the engineer and the pure scientist are of such a very different nature. It must, of course, be granted that the work of most practicing engineers is only distantly related to the work of the members of this Association belonging to the various sections, with the exception of D. But, on the other hand, a great many of the practicing engineers and of the professors of engineering do truly scientific work, and, what is more, in the opinion of the speaker, the preliminary training of the engineer is perhaps the best yet found to educate a man for future scientific research work.

These facts have led the speaker to believe that a consideration of the subject announced might perhaps increase the interest in Section D, and possibly thereby help to prevent its disappearance, which, to many of us, has seemed both imminent and deplorable.

Presumably our friends, the pure scientists, will shake their heads significantly when they read the title of this address, and if any of them should happen to hear it, or later read it, they might perhaps even go so far as to bestow a smile of pity on us poor engineers, etc., who have such a high opinion of our own worth. But even if none of our scientific brethren should be converted, the speaker would feel satisfied with the results should he succeed in giving more confidence to the members of the engineering profession in its broad sense as possessing the necessary training for accurate and important scientific research work.

The proposition which I expect to defend in this address is that engineering education as furnished in the best technical schools of the world, together with the training obtained later in life as a practicing engineer, probably furnishes the best preliminary preparation for the successful prosecution of scientific research work. I am now speaking of the preliminary training; the special knowledge of the subject in which the research work is to be done

* Address of the Vice-President before the Section of Mechanical Science and Engineering, American Association for the Advancement of Science, 1899.

must of necessity be acquired in addition to this engineering education, except when such work is in some one of the engineering branches. I desire also to call your attention to the fact that I do not mean to say that it is the only true method to gain the desired end, but that I have the feeling that, although all roads lead to Rome, yet this one is perhaps the most direct and possibly the best paved.

The object of scientific research work is, as I understand it, to ascertain the facts of nature, to correlate these facts, and finally to deduce the laws of nature as illustrated by the facts discovered. It is probable that a better definition might be given, but for the purpose of this address it is desirable that the various objects of scientific research work be given in something like the form above, and I feel very confident that the definition is one against which no serious objection can be raised. It will be noticed that I divide scientific research work into three parts, and I am sure that everybody will agree when I say that most of the scientific work done to-day is along the first line. The work of correlating the facts discovered is less common, and drawing conclusions from the facts thus correlated by establishing the laws of nature is of such a character that but few scientific workers get so far. That this is the case is but natural, because of the difficulties of the problem, and, although it is the most important of all scientific research work, yet, even of those who work in this special line, there are but few who are able to draw the correct conclusions, and this because of the lack of proper judgment in weighing the importance of supposed evidence and facts, or because of lack of previous training in suppressing the natural tendency to overestimate the value of one's own labor. I take it for granted that everybody appreciates the difficulties and failings which, because of the previous preparation, or, perhaps better, because of the lack of previous preparation, necessarily attach to the scientific research work of to-day. An inquiry into the necessary and desirable qualifications for a man working in this line will, I think, most rapidly lead us to the heart of the question raised in this address: Is not engineering education a remedy for a good many of the weaknesses found in the ordinary scientific man?

These qualifications will here be given separately as effecting the three kinds of work into which I have divided all scientific research work: First, what should be the previous training of a man who is to ascertain the facts of nature? He must necessarily have his faculties of observation trained to the highest degree, so that he sees the facts as they actually are, and, perhaps more important yet, that he can see the single fact which he is looking for, without being disturbed by surroundings which, in the eyes of the untrained man, would obscure the perhaps small objects for which the investigator is looking. It is also very necessary that the observer should be able accurately to describe the object, or fact seen. His mental habit should be such that accuracy is a necessity. And, finally, I think that the scientific worker should, for many kinds of observation, have his hands trained in such a manner that necessary apparatus can be used intelligently and even designed and made.

Second, what are the special qualifications for collecting and correlating the isolated facts of nature, as discovered by others? It seems to me that if anybody is to do this successfully he must possess all the qualifications of a worker in the first line, except that possibly he does not need the manual dexterity which is required by the original investigator. In order properly to classify the facts according to already existing rules and laws, he must also be familiar with the methods by which the

facts have been gathered, in order that he may be able to judge whether the results obtained by original investigators are really facts or only delusions. This man must, therefore, necessarily have a wider experience and outlook than the first observer, and he must possess a sharper judgment, which can only be obtained by special training.

Third, the scientific man who, from a large amount of material collected and correlated by others, shall be able to draw correct conclusions, so as to establish the laws of nature must necessarily have very special qualifications. He must not only have a wide outlook and a profound learning in his special branch; he must in addition be sober-minded, must be able to weigh evidence as thoroughly and impartially as the best qualified judge, and must not only see clearly, but be able to 'go behind the returns' so as to be in a position to decide whether the evidence presented is relevant to the case in question and if it be, whether it really represents facts. Having sifted the evidence, he must be capable of so surveying the field that the general law of which the isolated facts are exponents will reveal itself to his mind. For this latter purpose and to prevent visionary conclusions, I take it that a rigid training in accuracy and sobriety is required.

It is my contention that a man who has received a thorough engineering education, and perhaps has added a few years of professional work to scholastic training, is as well prepared to take up scientific research work as anyone coming from our universities and colleges. I do not think that anyone will deny that the work which is required of the engineering student in our best colleges tends very largely to establish a habit of accuracy, which, as was pointed out before, is one of the most essential qualifications of a scientific man. There is no study like mathematics, with its various applications, to teach a man accuracy; and, as this study forms the backbone in all engineering courses, it is only to be expected that the engineering student, when he leaves college, shall have acquired a habit of mind which makes it impossible for him to be inaccurate, either in his work or in his mode of expression. It is also my belief that the study of mathematics teaches truthfulness and sobriety of thought. As was explained before, the latter I deem one of the most essential qualifications for the man who is to do the highest grade of scientific work. Engineering education and the practice of the engineering profession will necessarily teach this sobriety of thinking more thoroughly than any other kind of education. The object of the engineering professions is to utilize the laws and forces of nature for the well-being of the human race. Consequently the engineer must build upon the laws of nature, must apply them, and the results of such application we see in the innumerable achievements of the engineer of modern times. The true engineer first surveys the field, then makes his plans and computations, based upon his observations and upon the laws of nature; the result of such work is, for instance, either the machine which is to do a certain work or the bridge which is to carry the modern heavy railway train, or it may be one of those monster buildings which within the last few years have been erected in the large cities. If the preliminary work of the engineer has not been accurate, or if he has not applied the laws of nature correctly, the result is inevitable; the machine will not do its work, the bridge will not carry the train, or the tall edifice building will not carry the enormous weight concentrated in it. The punishment will follow the mistake of the engineer as surely as the earth keeps on moving around the sun. This is the

great point in engineering education which, at any rate in some respects, makes it the best preliminary training for men who are to do scientific research work. A good engineer is necessarily an accurate man ; he is necessarily also a soberly thinking man, and, thirdly, he must also possess a discriminating judgment, as the results which follow superficial reasoning or visionary planning are fatal to all engineering work. There are no studies which teach this lesson so strongly as the various professional engineering studies, and it seems to me, therefore, that one of the most essential qualifications for doing thorough scientific work is obtained in a higher degree by engineering education than by any other training. It is true that the ordinary engineering student has but limited opportunity to test his plans and computations in actual practice. But it must be remembered that the student is always reminded of the inevitable results of even one false step in the class-room, laboratory and draughting room, and that his work is controlled by men who are supposed to have had the necessary experience in practical life. That the actual practice of the engineering profession is the best teacher in this line need hardly be stated. The work of the engineering student in the draughting room, in the shop and in the laboratory fits him peculiarly for scientific research work, as he there gains the necessary dexterity of his hands, his powers of observation are being trained, and he learns to be accurate and neat. The only objection which perhaps might be raised against my contention is that the engineering courses of study are narrow in their nature, and consequently that the graduate of an engineering college will be a narrow man. It is true that in a certain sense the course of study is narrow ; it does not include any classics, for instance ; nor does it include as much of the humanities as is desirable. But, on the other hand, specialization has gone so far in the present day that I think I am correct when I state that, for instance, the ordinary classical course, with its excessive amount of Greek and Latin, is fully as narrow as the engineering course ; and as to the scientific college course it is enough to say that there is no reason why it should be deemed less narrow than the engineering course, except for the fact that specialization has not been carried so far. The ideal engineering education is first an academic course, followed by two or three years' work in the engineering college, and if such length of time of study is not deemed too much for the profession of a lawyer there is no reason why it should be too long for the engineer. A man educated as just indicated would certainly be better fitted for scientific research work than any other college graduate who had an equal amount of time for preparation but had taken no engineering work.

That the engineer of the present day is doing a large amount of scientific research work does not need any proof, and because of his training I am of the opinion that his work is of a better quality than that of the ordinary scientific man ; more reliance can be placed on it, as it necessarily has had to undergo a more severe test, both for accuracy and soundness in conclusion, than if it had been done by a person who had not had the preliminary training of an engineer.

To disprove this statement I suppose that some one might very likely mention the name of Kreidler, or perhaps even that of Kelley, but it is sufficient to state that these men are not, nor were they ever engineers, and it might also be pointed out that engineers are not responsible for any of the perpetual motions which, even in this enlightened day, seem to be as numerous as they ever were.

In conclusion, I desire to repeat that we engineers, or semi-engineers, need to feel

that our work is very often scientific research work of the highest character, and that although we are very often told that because of its practical nature it does not belong to pure science, yet we should insist that, whether it be pure science or not, it is scientific work, and because of our previous training is likely to be of permanent value.

I desire, finally, to offer an apology for the shortcomings probably altogether too visible in this address, and to express the hope that Section D of the American Association for the Advancement of Science, because of the large and important field which it represents, will start in on a new era of prosperity.

Storm Bull.
University of Wisconsin.

FAUNA AND FLORA OF PUERTO RICO.

In the past the island of Puerto Rico was densely populated. Before Columbus discovered America and Ponce made his first European settlement on the island there had been two races on it, and each had occupied practically the whole of it. The first was, to judge by its shell heaps and other remains, a people of Northern origin, and the other was of the Carib race. At the time of the occupation by the Spanish the population was, according to their reports, as dense as it is now. It is now the most densely populated rural community proper on the continent of America. It has upwards of 230 inhabitants to the square mile, and this is strictly rural, as it has no great cities, the largest being of less than 40,000 inhabitants. The people generally live in the country, and the country huts are scattered in all sorts of places, expected and unexpected, from the crests of the mountains to the coasts.

Under these conditions only a very small original or wild fauna can be expected. Generally speaking, the largest wild mammal is a ground squirrel, about the size of a gopher. A few others of larger size are reported from time to time, but they are only occasional and are probably animals escaped from cultivation. Probably the larger animals once existed, and their traces could doubtless be found by a linguist in the place names which abound all over the island and are quite often not Spanish, but these creatures have been so long gone that they are not even mentioned by the natives, nor do the customary traditions otherwise refer to them.

The largest bird on land is the pretty white heron, of about the same size as the common heron of the Northern States. It belongs in the swamps. The nightingale is not rare, and sometimes in winter some of the Northern songbirds are seen, but in general the avian fauna is very sparse. The song and twitter of the birds is very rarely heard. Along the coasts the pelican, large and clumsy looking, except on the water, is very common where it is very much occupied with its profession of fisherman. It prefers protected harbors to the open water outside, and shows no greater shyness of man than to keep in the less disturbed waters of the ports.

The most common quadruped, by all odds, is the little lizard or swift, which can be seen almost anywhere in the sun and even frequently penetrates houses and lives with the family. They are very quick, intelligent, cleanly creatures and are only dangerous to cockroaches, flies and other small vermin. The largest land reptile is a snake, which sometimes reaches six or eight feet in length, something like the black snake, but called a python. It does no harm, so far as learned. There are a few other species of less size whose venom is not yet proved and is not feared by the natives.

The land crabs, snails and other such creatures are far from common, except in marshy places and near the coast. The

largest crab seen in some months' residence was a brilliantly colored pink and black one which belonged exclusively in the mangran swamps. Its very bright, clean coloring, its commonness there and its movements, characterized by a certain shifty handiness, make it a very striking object.

The greatest attraction of Puerto Rico for its tropical position is its relative freedom from insects, especially the noxious and troublesome ones. The scorpion and centipede are so rare that they are very seldom spoken of by the natives, and the so-called tarantula is only an overgrown spider, so far as learned not so large as that of New Mexico. The cockroach is common enough and sometimes reaches an enormous size before his fate overtakes him. Mosquitoes are generally not troublesome. Doubtless there are spots and seasons for an abundance of them, but these are not easy to find. The easterly breeze so common over the island and usually felt from afternoon to morning keeps these insects down.

The malignant germs of disease are not so much at home in Puerto Rico as in most other parts of the shores of the Caribbean. They can be introduced there and under favorable circumstances may have a considerable run—much as they would on the Gulf Coast of the States. The island is known as the healthiest of the Antilles and its winter season especially is most wholesome and charming.

The wild plant life has suffered equally with the wild fauna by the prolonged and all-pervading cultivation the island has received. Each part of the island not absolutely uncultivatable, even steep declivities, has been cultivated again and again, and even now slopes are carefully prepared for crops which are steeper than anything probably thus used in the States. They are so inclined that a loosened stone will roll down hundreds of feet and the cultivator hoes at nearly the level of his head.

The wild plants have little chance except on lands which for various reasons may have been neglected. In such places jungle and woods rapidly cover up the traces of cultivation and a few years change a field into a forest. There are many places that look like forests that are in a high state of cultivation, for many of the crops of Puerto Rico require shade when young and windbreaks when older. These crops may be grown in a natural forest from which all unnecessary trees and brush have been removed, or, more often, the man who owns the place makes a planted forest out of trees of certain species suited to protect the plants. Thus it happens that the island is much more generally forest-covered than its highly cultivated condition would indicate. Coffee is the crop most cultivated in this way.

The palms are few in kinds and in individuals. The commonest are the cocoa and the cabbage palm. The former loves the salt air from the ocean, but on this insular area it can be found at the greatest distance from the sea, here not more than twenty miles or so. The palm trees furnish thatch, standards, joists and siding for the native huts of the country, and the cabbage at the apex of the cabbage palm is used for food, though each cabbage costs a palm tree.

There are besides some scores of useful timber trees in the island, but they do not often occur in trunks large enough for the saw mill. The total number of such trees on the island must be considerable, but they are scattered, not in continuous forests, and are about as likely to be in villages as in the country. Besides, the wood is often too hard and the trunk too irregular and unsymmetrical for convenient use in the mill. The virgin forests are very few, perhaps none strictly virgin. There are in the mountains some areas that have the appearance of virgin forests, but they do

not have many large trees, and possibly do not date from many scores of years back. The Island of Culebra, a small island lying to the east of Puerto Rico and belonging to it, is said to be covered by virgin forests. There are several species of tree ferns on the island, always occurring at some distance back from the coast—and on the northern slope, so far as observed. They rarely surpass twenty feet in height.

Meadows have to be made, and for this a crab grass and a festuca or fescue-grass are used. The former is a good strong grass for the meadow and also makes an abundant, excellent, high-green hay. The hay could be imported into New York at a less cost than the inferior hay from up in the State, and could be brought into the market still fresh in the winter and early spring. The fescue is a better grazing grass and grows with great rapidity and to great height when it can support itself on shrubby vegetation. Cattle graze in it up to the brisket, and in protected places along the fences it is often seen from ten to fifteen feet high.

MARK W. HARRINGTON.

THE BOTANICAL SOCIETY OF AMERICA.

THE sessions of the 5th annual meeting of the Society were held on Friday and Saturday, August 18th and 19th, in Townshend Hall. The meeting was called to order by the retiring President, Dr. N. L. Britton, who then resigned the chair to the President-elect, Professor L. M. Underwood.

Officers elected for the ensuing year were :

President: Professor B. L. Robinson, Harvard University.

Vice-President: Professor B. D. Halsted, Rutgers College.

Secretary: Professor G. F. Atkinson, Cornell University.

Treasurer: Dr. Arthur Hollick, Columbia University.

Councillors: Professor D. P. Penhallow, McGill University, and B. T. Galloway, U. S. Dept. of Agriculture.

New members elected were :

Professor J. M. Macoun, Canadian Geological Survey.

Dr. W. J. Beal, Agricultural College of Michigan.

Dr. C. F. Millspaugh, Field Columbian Museum.

Dr. M. A. Howe, Columbia University.

On Friday evening the retiring President, Dr. N. L. Britton, delivered a public illustrated address in the chapel of University Hall, on: 'Report of Progress of the Development of the New York Botanical Garden.'

The following papers were read at the several sessions of the Society, in addition to which a number of others were read by title :

'Apetaly and Dioeciousness.' Professor C. E. Bessey, University of Nebraska.

'Symbiosis and Saprophytism' Dr. D. T. MacDougal, New York Botanical Garden.

'The Effect of Centrifugal Force upon the Cell.' Professor D. M. Mottier, University of Indiana.

'The American Species of *Arisæma*.' Dr. N. L. Britton, New York Botanical Garden.

'The Classification of Botanical Publications.' Professor Wm. Trelease, Missouri Botanical Garden.

ARTHUR HOLLICK,
Secretary pro tem.

SCIENTIFIC BOOKS.

Naturalism and Agnosticism. The Gifford Lectures delivered before the University of Aberdeen in the years 1896–1898. By JAMES WARD. Two volumes. The Macmillan Co. 1899.

The purpose of Ward's two volumes is not to defend scientific naturalism from the implication of agnosticism, but to show that the only way to escape from the 'determinism' of the naturalist is through philosophical idealism. The book is able and thoughtful and original, and one which all students of science would do well to study. For this reason I shall make no attempt to present a summary of its contents, although I shall try to call the attention of those who have read the book to a point of view which is very different from that of the author.

If one of the lessons of history is that dogmatism is the greatest foe of scientific progress, another lesson is that nothing has done more than reflection upon the meaning of nature to make natural knowledge definite and distinct, to strip it of all side-issues and irrelevant complications, and to put it into the form that commands assent; but the student must remember that the search for purpose in nature has been good for science only so far as it has been earnest and fearless, and, above all, single-minded; for very slight acquaintance with literature is enough to show that, among the motives of many writers upon natural theology, we often find evidence of a desire, conscious or unconscious, to find in nature support for some system of dogmatic theology rather than a basis for natural theology.

That the growth of natural knowledge has been uninterrupted and irresistible is due, in no small measure, to the desire which most of us feel to find out, if possible, what natural knowledge means. There are some, no doubt, who find in this the teleological argument, and see no reason for further search. If effort to find meaning in nature has clarified our concrete knowledge the advantage we have already found in natural knowledge may be its meaning.

Ward, as I understand him, does not share this opinion; for unless the meaning of knowledge is the advantage we are yet to find in it, as distinct from that which we have already found, he assumes that there can be no evidence of intention in nature, for he is one of those who hold, with Satan in the Book of Job, that no one can be expected to serve God for naught.

He tells us—II., 251—that, unless natural law is 'necessary,' the outlook is gloomy; for while the 'conception of Nature as a system of laws is hypothetical' the hypothesis is 'necessary' to our welfare, because 'knowledge of these laws is an indispensable means to that subjugation and control of nature upon which human welfare and advance in large measure depend.' The conception of nature as an ordered whole is therefore 'necessary,' since without it there could be no experience, and therefore no life, since 'experience is life.'—II., 231.

If I understand the naturalist and may be permitted to speak for him, he also holds the necessity of natural law to be necessary for our welfare as rational beings, although he is disposed to ask whether expediency may not be a better word than necessity. Food and drink are necessary to our welfare in this sense of the word, although it by no means follows that we are to have food and drink, for men have died of starvation, and we fail to find in nature any assurance that we may not all so die, for the fact that food and drink are necessary—that is, to be desired—is no evidence that we are to have them.

The naturalist agrees with Ward that our conception of the order of nature is not absolute, but contingent or relative, but he is not prepared to assert that it is a hypothesis; for a hypothesis is a mental product, and he does not know whether the contingency is mental or organic; whether—to use the language of the idealist—it is a sign, or the significance of a sign; whether it is a part of our actual experience or a part of that 'possible experience,' which, we are told, is necessary in order that there may be actual experience.

At any rate the naturalist is quite ready to admit that our conception of nature as rational order is a part of our constitution as rational beings. Using the language of his own little shop, he holds that it is a part of us, "as Nature has made us," although he admits that nature cannot 'make' anything, since nature is neither more nor less than that which is.

Ward tells us that the conception of natural law as necessary to our welfare is teleological, because our rational nature is due to the efficiency of a 'teleological factor,' or Lamarckian principle in the origin of species—Lecture X: that it is teleological because man has made himself, or, at the least, has had an efficient and intelligent part in making himself.

The naturalist, like the idealist, admits human agency, and tries to find out in what sense he is an agent, just as the idealist, while admitting a world of things, tries to find out in what its reality consists. To assert that man has made, or helped to make, himself is not to discover, but to assume, evidence of purpose in human nature. If such language is permissible it is hard to see why is is not also permissible to assert that nature has made men,

or even that "some of nature's journeymen had made men, and made them not well"; for the real question at issue, in each case, is how far the language is figurative.

The context seems to show that Ward does not hold his words to be figurative, for he asserts that not only man, but every living thing, has had an efficient and conscious part in its own production.

"Call an organism a machine, if you will," says he, "but where is the mind that made it, and, I may add, that works it?" And he answers this question by the statement—I., 294—that, while this mind is outside the dead machine, it is inside the living machine or organism and identical with it; for he contends that "mind is always implicated in life," or that, in other words, "a teleological factor, analogous to that of Lamarck, is operative and essential throughout all biological evolution." The context shows that it is not simply as part of an intended system of nature, but as an active agent of efficient cause, that each living thing is said to take part in its own production, although it is not easy to reconcile the statement—I., 294—that the mind of the living thing is inside it with the declaration—II., 127—that it is a 'metaphysical travesty' to assert that a mind can be inside a body. Clearly some of the author's language is figurative, and the reader must find out, as well as he can, what to take literally and what with a grain of salt. However, since "Natural selection works blindly upon promiscuous variation blindly produced," it is, of course, inadequate as a basis for Ward's idealism; although the assertion, in the next sentence, that it is immeterial for natural selection how variations are produced, seems to show that it may be the eyesight of the process and not that of the product which is defective, if one is able to find any meaning in the statement that a process is blind.

While admitting the existence of the selective process, Ward fails to find in it any efficiency, causality or agency, and the naturalist is more than ready to agree with him, for to him also selection is only a statement of fact and not an efficient cause. He, therefore, fails to see how it can be either blind or possessed of eye-sight. Ward, finding natural selection blind, believes that he finds for it a ποῦ στῶ in the Lamarckian principle that "the production of a new organ in an animal body (or in a living body) results from a new want arising and continuing to be felt, and from the new movement which this want initiates and sustains," while the naturalist, if he be also a teleologist, finds the ποῦ στῶ in his conviction that it is good to have lived.

Ward, admitting selection but finding it blind, believes that its raw material must be supplied by a 'teleological factor' before it can 'do' anything. He, therefore, asserts that both a non-teleological factor—*natural selection*—and a teleological factor are concerned in the origin of species. He admits that the "complete unravelling of the two sets of factors, teleological and non-teleological, so as clearly to exhibit their respective shares in any given form is probably an impossible task," although we must ask, in this case, how he knows that there are two. "Not a few temples to the Deity founded on some impressive fact supposed to be safely beyond the reach of scientific explanation have," he reminds us, "been overtaken and secularized by the unexpected extension of natural knowledge."

He says that if we understand mind as always implicated in life and operative and essential throughout all biological evolution "we come upon two principles that lead us straight to the teleological factors of organic evolution." One of these is the principle of self conservation; the other is the principle of subjective or hedonic selection. "These principles furnish natural selection with the ποῦ ὅτῶ it seems to demand."

"By the principle of subjective selection special environments are singled out from the general environment common to all." "Take the passengers on a coach going through some glen here in Scotland; in one sense the glen is the same for them all, their common environment for the time being. But one, an artist, will single out subjects to sketch; another, an angler, will see likely pools for fish; the third, a geologist, will detect raised beaches, glacial striation, or perched blocks. Turn a miscellaneous lot of birds into the garden; a fly-catcher will at once be intent on the gnats, a bulfinch on the pease, a thrush on the worms and snails. Scatter a mixture of seeds evenly over a diversi-

fied piece of country; heath and cistus will spring up in the dry, flags and rushes in the marshy, ground. * * * Two artists or two anglers may be in each other's way, but an artist and an angler will hardly incommode each other. A garden would still interest a fly-catcher if there were neither pease nor cherries in it, provided the insects remained. Natural selection, as distinct from subjective selection, comes into play only when two anglers contend for the same fish, two artists compete for the same prizes; when the early bird gets the worm that the later one must go without."

So far all seems clear, except that the seeds that fall by the wayside do not seem to have much opportunity to escape from natural selection, or to exercise their teleological factors, although Ward fails to tell us what will happen if the would-be artist has mistaken his vocation, or if the family of the fisherman are suffering because of his absence while he is looking for likely pools. As for the geologist, who seems to have dropped out of sight, he is an illustration of natural selection, for, as Berkeley has pointed out, "the work of science is to unravel our prejudices and mistakes, untwisting the closest connections, distinguishing things that are different, instead of confused and perplexed giving us distinct views; gradually correcting our judgment and reducing it to a philosophical exactness." The correction of our natural responses and their reduction to a philosophical exactness by the suppression of those that are confused and perplexed and the preservation of those that are definite and exact, and, ultimately, by the extinction of the deluded minds and the survival of those that are sane, is what the naturalist means by natural selection.

When we consider how marvellous are the activities of a living organism, and how far the wisest man is from perfect knowledge of even the simplest organic mechanism, it is clear that we cannot hope for much from its attempts to give intelligent help in its own production; and Ward tells us that the condition of progress "seems provided, without any need for a clear prevision of ends or any feeling after improvement or perfection as such, simply by the waning of familiar pleasures and by the zest of novelty. In the midst of plenty it is usual to become dainty and to make efforts to secure better fare, even though the old can be had without them."

"Thus—even if there were no natural selection of variations fortuitously occurring, and even if there were no struggle for subsistence, still—the will to live, the spontaneous restriction of each individual to so much of the common environment as evokes reaction by its hedonic effects (with the increasing adaptation and adjustment that will thus ensue) and, finally, the pursuit of betterment to which satiety urges and novelty prompts—these conditions, really implying no more than the most rudimentary facts of mind, will account for definite variations to an apparently unlimited extent. What is more, the variations so produced, even if there were no others, would furnish natural selection with an ample basis as soon as struggle for existence began."

Thus we find that, even if there were no natural selection, the principle of self-conservation, and the principle of the zest of novelty—selfishness and want of steadfastness—are enough to bring about exquisite adjustment of each living thing to its environment. To this, exhaustive analysis of Ward's two volumes brings us down, and from this, he assures us, a rational synthesis builds up the philosophy of idealism; for nothing is easier than for one who is not a naturalist to improve upon the work of Charles Darwin.

The naturalist may be disposed to ask, however, whether unselfish interest in the welfare of the race and of posterity may not be at least as important in the history of organic evolution as 'the teleological principle of self-conservation.' Inasmuch as innumerable species have been exterminated for each one which now survives, and inasmuch as it can be proved that the genetic lines of most of the living organisms that now exist are destined to rapid extinction, it is clear that, as a matter of fact, most living things that have had a part in the selection of their environment have made more or less of a mess of it; for no one except a philosopher can lose sight of the truth that aptitude for experience is not, unfortunately, the same as aptitude for beneficial experience. It is at most no harder to acquire pernicious experience than to acquire

beneficial experience; no harder to cultivate bodily infirmity, or logical inconsequence, or mental imbecility, or moral obliquity, than to make the best of our faculties and opportunities.

The naturalist must also ask whether the contented enjoyment of normal life may not afford better evidence of intention than fickle lack of stability.

Those who are satisfied with the sort of natural theology which finds its type in filial affection, based upon gratitude rather than expectations, may possibly find evidence for this sort of teleology in nature, without first settling the disputes of the philosophers about the relation between mind and matter.

The most obvious answer to reasoning like Ward's is that we fail to find in nature any reason why all life, or, for that matter, all nature, may not come to an end this instant; for the assertion that the stability of nature is necessary to our welfare means nothing more than that this stability is much desired by those who have found life worth living.

If we are sure only of the present and of the past, and if science gives us nothing more than reasonable expectations about the future, which may or may not prove well founded, it is evident that we must look to the present and to the past for evidence of purpose in nature if we are to find it in nature at all.

They who are dissatisfied with this sort of purpose, and tell us it weighs upon them like a nightmare, must remember that there is no reason to doubt and good reason—as good reason as our own existence—to expect that the future will, on the whole, be essentially like the past; and that while the so-called predictions of science are no more than reasonable expectations they are reasonable expectations, since they are part of our nature as reasonable beings, as we have come about in accordance with the mechanical principle of natural selection.

If I am sure that natural knowledge has been useful and profitable and delightful to me I am as utterly unable to see why the discovery of a mechanical equivalent for truth should affect this conviction as I am to see how the scientific study of the mechanism of digestion can destroy my conviction that food and drink have, on the whole, been good for me: as unable as I am to see here proof that I do nothing which one who had exhaustive knowledge of any organic mechanism might have expected one to do, would prove that I am not reasonable and responsible. It is true that I have suffered because of my food, but I have never suffered from natural knowledge, and better knowledge of the mechanism of digestion might have helped me to avoid this suffering.

So far as I understand the scientific frame of mind, and may be permitted to speak for the naturalist, he is neither a materialist nor an idealist nor an agnostic monist, although the 'possible experience' of the idealist seems to him to afford ample room for a physical universe as material as the most ardent materialist could desire. It also seems to him that if common folks are to refrain from a search for purpose in nature until the philosophers have settled all their little questions and have reached an agreement among themselves they had better abandon all hope of finding the meaning of nature.

Each new philosopher assures us that his only motive is to help us to reach the truth and to set our minds at rest, but it may be that while philosophers fall out the simple-minded men of science may come by their own and live at ease.

W. K. Brooks.
Johns Hopkins University.

The Races of Europe. William Z. Ripley. New York, D. Appleton & Co. 1899. Pp. xxxii+624. Accompanied by a Supplementary Bibliography of the Anthropology and Ethnology of Europe, published by the Public Library of the City of Boston. Pp. x+160.

The interesting series of articles on the physical anthropology of Europe which Professor Ripley contributes to *Appletons' Popular Science Monthly* has been published in a revised form under the above title, accompanied by a very full bibliography of the subject. The work is based on a study of the very extensive published and much unpublished material that has been collected in various parts of Europe, and is an attempt at coordinating the results obtained by European investigators. The labor and the difficulties involved in a task of this kind are formidable, and the author deserves the thanks of all students for having made

easily accessible a vast amount of scattered literature. He has set forth, with great clearness and in a most fascinating form, certain results obtained by detailed statistical inquiries of great magnitude. The graphical coordination has been made with admirable skill, which will appeal to every one who knows the difficulty involved in combining material collected according to different methods and under different conditions. For this reason the useful and highly instructive maps of a large portion of Europe, and even of the whole globe, must be taken for what they are intended—as graphic representations of the known features of various human types so far as known at the present time, but without any claim to absolute accuracy, which in the present state of our knowledge would be impossible. The material comprised in these maps enables the author to present concisely and clearly a number of the most important problems of European somatology.

The primary object of Professor Ripley's studies is the explanation of the present distribution of human types in Europe. Four factors determine the same: heredity, environment, chance variation and selection.

It is a difficult task to ascribe to each of these its proper sphere of influence in the development of the human types inhabiting a continent whose people have undergone so many changes of location as those of Europe. Professor Ripley agrees with most authors in recognizing three fundamental types in Europe: the long-headed, dark Mediterranean; the short-headed, brunet Alpine; and the long-headed, blond Teutonic type. The author rightly dwells on the fact that, on the whole, human types are comparatively stable in given areas, and for this reason prefers to give to the types geographical names (p. 128). He suggests that it would have been desirable to designate the type of northwestern Europe also by a geographical term—such as Deniker's 'Nordic'—rather than by a national term, such as 'Teutonic,' which he uses throughout. The prevalent types of various regions he explains largely as due to mixtures of these fundamental types, and as modifications due to environment, chance variation and selection.

The multiplicity of these causes and our lack of knowledge of the mode of their action make all conclusions based on them very doubtful. The causes may be combined in various manners to explain a given phenomenon. The lower stature of mountaineers is explained by less favorable economic conditions, while the still less favorable influence of the highest region is said to be counterbalanced by its selective influence, which eliminates the less vigorous elements of the population. When the obscure effects of social or geographical environment are insufficient to explain existing conditions, heredity as expressed by mixture, and selection or chance variation, enter as convenient factors which enable us to find a plausible explanation. The ease with which the extremely complex phenomena can be explained by various combinations of these causes seems to me a reason of weakness of the conclusions set forth by Professor Ripley. Our ignorance of the conditions which influence modification of inherited form suggest that before accepting a given theory we should seek for historical corroboration of the same. This has been given in a few cases, as in the discussion of the types of Britanny (p. 101); but sufficient historical and archæological evidence is not available or has not been given to raise many conclusions beyond serious doubt. It would seem that combinations of causes such as are brought forward to explain the conditions in Burgundy (p. 144) are so uncertain that they cannot be considered more than a very risky hypothesis. The uncertainty of this method is also well illustrated in the discussion of the characteristics of the types of the Alps. The author is led to explain in many places the permanance of the Alpine types by the remoteness and unattractiveness of Alpine valleys, while in others the high variability of the Alpine population is explained by the assumption that the valleys contain the 'ethnological sweepings of the plains' (p. 106). Historical evidence is just as much necessary in the study of physical types as it is in that of geographical names, which are very liable to lead to erroneous results, unless studied in their oldest accessible forms. Only when our knowledge of the causes influencing human types is much more definite than it is now may we hope to reconstruct the de-

tails of their history without the corroboration of historical evidence. Many of the explanations contained in the book are certainly plausible, and add very much to its attractiveness; but I should be inclined to emphasize the elements of uncertainty much more than the author does.

On the whole, Professor Ripley considers economic attractiveness as one of the principal causes that regulate the distribution of types. According to his theory the fertile plains were always subject to foreign invasion, while the less fertile hills contain the most ancient types. While in historic times, when population had reached a considerable density, this cause must have been very effective, we may doubt if it acted in the same manner in very early times, when the continent was sparsely settled, when agriculture was not the only means of subsistence and when dense forests and swamps, difficult of access, or steppes that are now fertile occupied plains. The author calls attention to the fact that the invasion of the Alpine type cannot be explained in this manner.

I feel least in accord with Professor Ripley's ready resort to mixture as an explanation of peculiarities of type. This view is closely connected with the interpretation of what constitutes a type or a race. I do not think the term 'Races of Europe' a fortunate one, but, with Gerland and Ehrenreich, I am inclined to reserve the term for the largest divisions of mankind. The differences between the three European types are certainly not equal in value to the differences between Europeans, Africans and Mongols; but they are subordinate to these. The term 'type' appears most appropriate for the sub-divisions of each race.

It would seem that if the author had given us in his work not only an analysis of what differentiates the various types of Europe, but also a description of what is common to them —a subject that would seem eminently proper in a discussion of European man—his views might have been somewhat modified. The important anatomical characteristics of the race as a whole have found no place in his work; in the chapter on European origins (pp. 457 ff), in which he deals with the general question of race, only the anthropometric evidence and pigmentation are treated. Considering the most generalized form of the European race as it reveals itself in the child, we should be inclined to consider it a highly specialized form of the Mongoloïd, type from which it departs principally by the peculiar development of the nose and adjoining parts of the face and by a general decrease of pigmentation. On account of the high degree of variability; of the originally small distribution of this type, and of the apparent tendency of hybrids with other races to revert to the other parental race rather than to the European Race, I should be inclined to consider the European one of the latest human types. In early times this race was probably slightly specialized in a number of areas, each area exhibiting a considerable degree of variability. The loss of pigmentation, and change in facial form, were not equally pronounced everywhere, so that one region would be darker colored or broader faced than another, although not by any means uniform in itself. For this reason the occurrence of blondes or of narrow-faced and elongated heads in an otherwise dark, broad-faced and short-haired region does not necessarily prove mixture. At present we have no means of telling how stable these types had become before the extensive mixture which certainly has taken place throughout Europe. For this reason it seems a vain endeavor to seek for individuals representing the 'pure type,' even if there had been no mixture. In his discussion of the 'Three European Races' (Chap. VI.) Professor Ripley acknowledges the variability without, however, discovering that it makes conclusions as to mixture exceedingly doubtful, except in very pronounced cases.

It does not seem to me justifiable to consider all the individuals that are short-headed and brunette, although living in an area which, on the average, is long-headed and blonde, as belonging to the Alpine type, and to explain their presence as due to mixture between the two types. They may simply represent the remoter variations from the long-headed blonde type. This question has a most important bearing upon the explanation of facts of social selection (pp. 537 ff) by the assumption of different tendencies in the two types.

The problem can hardly be solved satisfac-

torily until we have acquired a much better knowledge than we now possess of the variabilities of the various types and of the degrees of correlation between the various features that characterize each type. This information is not yet available. No method has yet been devised for measuring the variability of pigmentation. The military selection, which vitiates so many anthropometric results, unfortunately often obscures the actual variability entirely. Thus all curves of stature in Livi's great work on Italy are asymmetrical on account of the elimination of all individuals below 155 cm. and the decreasing frequency of rejection correlated with increasing stature. This selection increases all the averages, and lessens the variabilities the more, the shorter the average of the type. Neither is it quite safe to take the irregularities of curves of distribution as evidence of mixture, unless they are subjected to a very careful analysis.

The author considers as the most valuable anthropometric characteristic the form of the head as expressed by the cephalic index, and depreciates the value of facial proportions and of absolute measurements. We cannot quite agree with this view. The cephalic index is often a most valuable means of distinguishing the types composing a race, but not by any any means the only one. Our selection of characteristic measurements must always be guided by existing differences, whatever these may be. Two types may have the same cephalic index and still differ in the general form of the skull and of the face to such a degree as to require separate treatment. Neither must we disregard the absolute values of the diameters of the head. The great length of the negro cranium as compared to its small capacity has a meaning quite different from the same length of the European cranium of large capacity. For this reason we cannot accept the daring map of the distribution of the cephalic index the world over (p. 42) as signifying any racial relationships. Cephalic index alone cannot be considered a primary principle of classification.

Neither are cephalic index and pigmentation alone a sufficiently broad basis for the characterization of racial types. The consideration of these two features leads the author to designate the European Race as intermediate between the African and Asiatic Races, without considering the great objections to this theory which are found in the form of the face, the size and form of the brain, the proportions of the extremities. Neither do we feel it safe to explain the fine, wavy hair of the European as due to a mixture between the frizzly African and the straight Asiatic hair.

We most heartily concur with the author's emphatic demand for treating physical, ethnographical, and linguistic methods separately. The misconception of what constitutes a racial type, a cultural group, and a linguistic stock has caused a vast amount of futile speculation. The three methods may be used, each in its particular domain, for reconstructing part of the history of mankind, and each may be used, to a limited extent, as a check on the two others. When two tribes of people speak closely related languages the inference may be drawn that they are in part related in blood, although the strain of common blood may be so slight as to escape anthropometrical methods entirely. Cultural similarity is no proof of blood relationship, since culture may be easily disseminated among tribes of different descent.

We cannot undertake, in this brief review, to discuss in detail the data and theories regarding the history and distribution of types in various parts of Europe. The book contains no tabular statements that would enable the reader to check any of them. It is the intention of the author that the student should verify his statements by the help of the very full bibliography which accompanies the volume. The 'Supplementary Bibliography of the Anthropology and Ethnology of Europe' is very complete in everything pertaining to anthropometry and to the study of pigmentation. The fact that Professor Ripley had to deal entirely with European literature is the cause that he uses the two terms Anthropology and Ethnology as meaning Somatology and Racial Classification, while their American use is quite different, Anthropology denoting the science of man in general, and Ethnology dealing with the activities of man. The supplementary titles bearing upon linguistics and archæology are not intended to be exhaustive, but merely refer to the subjects

treated in the text. The titles are conveniently arranged, and, on the whole, accurate, although the proof-reader might have been more consistent in spelling and more careful in reading the titles of foreign publications. The entire omission in the discussion of anatomical characteristics peculiar to the race as a whole and of the characteristics of the inner organs is, of course, repeated in the Bibliography.

The omission of all detailed and tabular matter have helped to give the book an attractive and popular form, but it has made it impossible to substantiate adequately any of the theories which the author advocates. It is to be feared that this method may mislead the general reader to believe that physical anthropology has accomplished much more than it actually has done, and that it may tend to perpetuate opinions which are likely to be materially altered by further inquiries.

FRANZ BOAS.

QUARRY INDUSTRY AND QUARRY GEOLOGY.

UNDER this title comes to us from the pen of Dr. O. Herrman, teacher in the Technological Institute at Chemnitz, Saxony, and from the press of Borntraeger Brothers, Berlin, an interesting volume of 428 pages on 'technical geology with practical hints for the commercial use of stone,' having special reference to the quarry industries of the Kingdom of Saxony. The briefest glance over its pages gives rise to the wish that we had as thorough a work on the building stones of our own country, for, in addition to its fullness of information, it possesses that rare quality of careful arrangement which is so seldom found in books. The work opens with a bibliography of the field covered, a list of institutions where building materials may be tested, with a brief tabulation of the modes of testing and a list of the geologic museums and larger study collection of rocks in Saxony.

The scientific discussion opens with a description of the rock-making minerals and their distribution; then follows a careful discussion of the rocks, their texture, composition and geographic distribution; next is discussed the physical and chemical properties of the minerals and rocks and the bearing of these upon the utility of the latter, and finally are considered certain geologic phenomena and their relation to the utilization of stone. Space is then given to the discussion of the most important uses of the more common stones worked in quarries. A chapter on modes of quarrying follows in proper order, concluding with a description of the methods for dressing the quarried stone.

The second section of the book, which is full of geologic and technical detail, is devoted to a discussion of the rocks of the Kingdom of Saxony.

The work closes with an appendix in which are discussed Saxon materials for road building and pavements, statistics of the quarry industries and a very useful tabular statement of the scientific and commercial characters of the different kinds of rock available for constructive purposes.

This work in its systematic arrangement is to the technological student what the classic works of Rosenbusch are to the petrographer. It must be conceded that we owe much to Germany for original research on the structure and classification of rocks and also for careful and accurate discussion of the facts determined. In our own country, unfortunately, at the present time, the knowledge of the architect and engineer on the subject of building stones is somewhat empirical and while accurate, since it is based on actual experience, is not fully collated and recorded in any one book to which one may turn for exhaustive information. It is to be earnestly hoped that the example of Dr. Herrman's publication will influence some one of our many competent authorities to group together and classify for publication all that is known about the building stones of North America.

F. J. H. M.

THE DEPOPULATION OF FRANCE.

THERE are interesting and important books on various subjects and there are also various books on interesting and important subjects. To the latter class belongs *Natalité et Démocratie*, written by M. Dumont and published at Paris by MM. Schleicher. The statistics are so badly arranged that it is difficult to find definite information, while the discussion does not carry much weight. But the problem is of extreme

importance. Only fifty years ago Malthusianism reigned. But applied science showed that the means of subsistence could be increased far more rapidly than the population. Now, in spite of the lowered death rate, the native population is actually decreasing in France and in New England, and is probably tending in this direction everywhere. The causes are not physiological, but psychological and social. M. Dumont blames the selfishness of democracies; he thinks that they are really aristocracies in which everyone wants to be an aristocrat and live in luxury. But it would probably be just as correct to blame our altruism. Our improved means of production, our improved hygiene, our charities and our sentimentalism have interfered with the struggle for existence, and fertility—physiological or psychological—has no longer a high selective value. It is doubtful whether M. Dumont will accomplish anything by preaching the patriotism and morality of large families. M. Bertillon's recent suggestion that an inheritance tax be imposed inversely proportional to the number of children is more reasonable, but it would only give a slight and temporary alleviation. The State would be more likely to succeed by the encouragement of early marriages, especially in the case of children from large families. But the whole problem is extremely difficult.

J. MCKEEN CATTELL.

GENERAL.

W. SCHMIDT'S *Heron von Alexandria* (B. G. Teubner; 15 pp., 3 plates; .80 M.) is a review of the first volume of a new edition of Heron's works. The article contains 39 figures (partly conjectural) illustrating the many curious and ingenious automata designed by Heron for public amusement in gardens and theaters. The article gives a good idea of the subject and is interesting to the philologian as well as to the mechanic and physicist.

NUMBER VI. of the Studies from the Yale Psychological Laboratory has just been issued. It contains: 'A color-illusion' (with colored plate), by Professor G. T. Ladd; 'Researches in cross-education,' by Professor W. W. Davis, and 'Researches in practice and habit,' by Dr. W. Smythe Johnson. A number of copies has been set aside for gratuitous distribution to persons who may be interested; a copy can be obtained by application to Dr. E. W. Scripture, New Haven, Conn.

BOOKS RECEIVED.

Proceedings of the U. S. National Museum. Published under the Direction of the Smithsonian Institution. Washington, Government Printing Office. 1899. Vol. xxi. Pp. xiii + 933.

Analyses électrolytiques. AD. MINET. Paris, Gauthier-Villars. 1899. Pp. 176.

Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1897, under the Direction of N. A. F. Moos. Bombay, Government Central Press. 1898. Pp. xviii + 12 tables. Price, 2s. 6d.

SCIENTIFIC JOURNALS AND ARTICLES.

Appletons' Popular Science Monthly for September opens with an article on the plague by Professor C. V. Vaughan, of the University of Michigan. In discussing recent legislation against the drink evil, Dr. Appleton Morgan argues that high licenses, damage laws and laws against adulteration are a sufficient remedy. Among the other articles is one on the milk supply of cities by Professor H. W. Conn; on the influence of the weather on crime by Dr. Edwin G. Dexter; on the survival of African music in America by Mrs. Jeanette R. Murphy, and a sketch of the zoologist Oscar Schmidt with a portrait as frontispiece.

DR. L. V. PIRSSON, professor of physical geography in Yale University, succeeds the late Professor O. C. Marsh on the editorial board of the *American Journal of Science.*

THE *Atlantic Monthly*, 'devoted to literature, science, art and politics,' but not in equal measure, has again changed editors. Mr. Walter H. Page has accepted a position in a New York publishing house and is succeeded by Professor Bliss Perry, of Princeton University.

DISCUSSION AND CORRESPONDENCE.

SCHEDULE FOR PSYCHOLOGY OF THE INTERNATIONAL CATALOGUE.

TO THE EDITOR OF SCIENCE: Professor Cattell is right in saying (SCIENCE, Aug. 11) that no scheme of classification for psychology

has been circulated with the other schemes by the Royal Society ; but one has been prepared. The present writer was asked by Professor Michael Foster to cooperate with Mr. Stout, the editor of *Mind*, who has been selected as the British representative of psychology. Mr. Stout prepared a detailed classification, which was extensively revised by my colleague, Professor Warren (the compiler of *The Psychological Index*) and myself. Our suggestions were all accepted by Mr. Stout and the schedule has been printed, a single copy reaching me some weeks ago. I know no reason for the failure of the committee to circulate it.

J. Mark Baldwin.

Princeton, August 16th.

The schedule for psychology was not presented to the Committee of Columbia University requested to report upon the plans. Neither, as I am informed, has it subsequently been sent to the responsible editor of Science, to the editor at present responsible for the *Psychological Review* and *Index* or to the professor of psychology of Columbia University. The proceedings of the Conferences on an International Catalogue of Scientific Literature appear to have been held in secret and concealed long thereafter. Science is, so far as I am aware, the only journal in the world that has given an adequate account of the conferences or extended reviews and criticisms of the plans. There is doubtless some reason for the methods of the Royal Society, but if the catalogue is to be begun with international assistance at the beginning of next year it is time that the explanation should be forthcoming.

J. McKeen Cattell.

POT-HOLE VS. REMOLINO.

To the Editor of Science: If more room can be spared for the discussion of so inconsequential a matter, may I say that a sufficient argument against the adoption of the word 'Remolino' lies in the fact that it is not needed. The term 'Pot-hole' is with us, and, whatever its origin, its meaning is plain. There is no more cause for substituting a Spanish word here than for the substitution of the Spanish language for the English as a whole. One can but be reminded of the ridiculous attempts at substituting French names for good old American and English dishes on the bills of fare in many of our restaurants and hotels.

George P. Merrill,
Department of Geology, U. S. Nat. Museum.

NOTES ON PHYSICS.

THE TRANSMISSION OF LIGHT THROUGH ABSORBING MEDIA.

Professor Oliver Lodge, in his presidential address before the London Physical Society,* gives a historical sketch of the theory of the passage of light through absorbing media (opacity), the subject being brought down to date ; in fact, Professor Lodge discusses some of Heaviside's results which are as yet unpublished. Those who are interested in the subject will find the address most interesting and instructive ; it cannot, of course, be abstracted.

W. Voigt, in Wied. Ann. 1899, No. 7, gives a general solution of the equation of wave propagation in an absorbing medium. This solution is identical in form to the solution of the 'telegraph equation,' so-called, which expresses the attenuation and variation of form of a telegraph signal. Voigt refers to Poincaré and Picard as having discussed this subject of telegraph signalling and of light transmission through absorbing media.

Readers of English cannot hold Voigt, Poincaré and Picard seriously responsible for their ignorance of the fact that this whole subject of light transmission through absorbing media and of telegraph signals has been very completely worked out by Heaviside, for probably a very few English readers are familiar with his remarkable work. Professor Lodge's presidential address, mentioned above, is almost wholly devoted to the discussion of Heaviside's work, apparently because of its preponderating importance and exceeding simplicity.

Lodge gives, in his address, the steps in the solution of the equation of wave propagation in an absorbing medium (Heaviside, 1887), which, compared with Voigt's solution, is simplicity itself.

* Proceedings of Phys. Soc., XVI., pp. 351–386.

SPREADING AND REVERSAL OF SPECTRAL LINES.

WANNER, Wied. Ann. 68, p. 143, 1899, describes the change of the sodium spectrum when the light from the flame is repeatedly reflected back and forth through the flame. He finds a spreading of the D lines, accompanied by a sharply defined reversal, and a weak continuous spectrum in their neighborhood.

W. Voigt, Wied. Ann. 68, p. 604, shows that this observation of Wanner is in qualitative accord with his theory of the emission of a layer of gas, which theory shows that in the radiation from a thin layer the wave-length which would be most absorbed would be of maximum intensity; while the radiation from a very thick layer would give a continuous spectrum with a dark absorption line; that is, a reversal of the original spectral line.

LECTURE EXPERIMENTS WITH THE WEHNELT INTERRUPTER.

E. LECHER, Wied. Ann. 68, p. 623, 1899, describes some very beautiful experiments showing the action of a magnetic field upon the electric discharge from an induction coil using a Wehnelt interrupter. The experiments illustrate the well-known sidewise movement of the spark (arc) across the magnetic field. The high frequency obtained with the Wehnelt interrupter, together with the fact that the discharge approaches the character of an arc, makes the effect of the magnetic field most striking in appearance; and the author describes several arrangements of the apparatus well suited to lecture-room demonstration.

VELOCITY OF ELECTRIC WAVES IN AIR.

MR. G. V. MACLEAN describes, in *Phil. Mag.*, July, 1899, a very successful application of the coherer in the location of the modes and antinodes of a stationary electric wave train reflected from a metal sheet. Mr. MacLean's object was to determine the velocity of the waves from the observed wave-length and the periodic time of the oscillator.

The coherers used consisted essentially of two platinum globules which were adjusted to delicate contact, and a milliamperemeter in circuit with the coherer and a battery gave the indications. The coherer gave no response at all at the nodes, and the readings over more than a whole wave of the stationary train were remarkably regular considering the erratic space action of the ordinary form of the coherer.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

THE great problem in obtaining argon from the atmosphere is to remove the nitrogen. In the earlier experiments, as in that of Cavendish, the electric discharge was passed through air confined over potash, whereby the nitrogen is gradually oxidized and absorbed. Later it was found that nitrogen was absorbed directly by various metals with different degrees of rapidity. Magnesium was first used by Ramsay, and somewhat later Ouvrard used lithium, while more recently Maquenne's mixture of magnesium with lime has been found practically most efficient. A very thorough study of the different absorbents has been made by Hempel, in the *Zeitschrift für anorganische Chemie.* He finds that lithium is five times as efficient as magnesium, the magnesium-lime mixture eight times, while if to a mixture of one part magnesium dust with five parts lime a quarter part of sodium is added, this absorbent is no less than twenty times as rapid in its action as magnesium alone.

THE early experiments of Professor Berthelot on the absorption of argon by organic compounds under the prolonged action of the silent discharge have now been very largely extended, and are described in the *Comptes Rendus.* With quite a large number of compounds of the fatty series, such as ethylene, aldehyde, acetone, propionitril, the result was negative. On the other hand, with benzene, turpentine, phenol, benzaldehyde, benzonitril and quite a number of other compounds of the benzene series from one to six per cent. of argon was absorbed, and at the same time there was a fluorescence of greenish color and with a characteristic spectrum.

IN the same number of the *Comptes Rendus* there is an interesting observation by M. Chesnan to the effect that chromous salts, like ferrous, have the property of absorbing nitric oxid. The compound formed, however, is

much more stable than the ferrous, for it does not give off the gas on heating nor in a vacuum.

The experiments of Weinland and Lauenstein have shown that in the alkali iodates an atom of oxygen can be replaced by two atoms of fluorin. Further researches on these fluorin salts have been carried out by Weinland and Alfa and are described in the *Zeitschrift für anorganische Chemie.* Quite a series of fluophosphates, fluo-sulfates, fluo-selenates, fluotellurates and fluo-dithionates have been formed. In all of these the fluorin does not directly replace the oxygen, but the $P=O$, $S=O$, etc., groups appear to be converted into $P<^{OH}_{F}$, $S<^{OH}_{F}$, etc. Most of these compounds crystallize well and their crystallographic characteristics are described by H. Zirngiebl.

In the *Zeitschrift für angewandte Chemie* the subject of a substitute for gasoline and benzine for many technical purposes is discussed by A. Ganswindt. The great danger from fire and explosion, ignition being caused even by the electric spark, is well known. The use of various chlorinated hydrocarbons is suggested, as carbon tetra-chlorid, which is, indeed, already used to some extent in this country. It is also possible that some of the chlorination products of acetylene may prove of real value along this line.

J. L. H.

RETURN OF THE WELLMANN EXPEDITION.

Reuter's Agency announces that the steamship *Capella* arrived at Tromsö on August 18th from Franz Josef Land. The vessel brought with her Mr. Wellmann's expedition, with which she fell in at Cape Tegetheff. It is reported that the expedition reached the 82d parallel of north latitude. The party bring with them the following remarkable story: In the autumn of 1898 an outpost called Fort McKinley was established in latitude 81, and a house was built of rocks and roofed over with walrus hides. During the voyage of the *Fram* two Norwegians named Paul Bjoervig and Bernt Bentzen remained there. The main party wintered in a canvas-covered hut at Cape Tegethoff, in latitude 80. In the middle of February, before the rise of the sun and in the depth of winter, Mr. Wellmann, with three Norwegians and 45 dogs, started north, this being the earliest sledge journey on record in such a high altitude. On reaching Fort McKinley they found the two men who had been with Nansen. Bentzen had died, and Bjoervig, in accordance with a promise he had made, kept his companion's body in the house, sleeping beside it through two months of Arctic darkness.

Pushing northward through rough ice, with severe storms and, for ten days, a continuous temperature of 40 to 50 degrees below zero, the party discovered men in lands north of the Freeden Islands, where Nansen landed in 1895. In the middle of March, when all hands were confident of reaching latitude 87 or 88, if not the pole itself, Mr. Wellmann, while leading the party, fell into a snow-covered crevasse, seriously injuring his leg, and the party, was therefore, compelled to retreat. Two days later they were roused at midnight by an earthquake, and in a few moments many dogs were crushed and sledges destroyed. The men narrowly escaped with their lives, saving their precious sleeping bags and some dogs and provisions. Mr. Wellmann's condition became alarming on account of inflammation, but his companions dragged him on a sledge, making forced marches for nearly 200 miles to the headquarters of the expedition, where they arrived early in April. Mr. Wellmann was still unable to walk, and he is probably permanently crippled. In subsequent sledge journeys the expedition explored unknown regions, and important scientific work was done by Dr. Hofna, Lieutenant Baldwin, and Mr. Hanlan. The expedition killed 103 walruses and eight bears. No trace of the Andrée expedition was found. The *Capella* picked up the expedition on July 27th and sailed homeward on August 10th. On the 6th inst. the *Stella Polare*, with the party of explorers headed by the Duke of the Abruzzi on board, was sighted in Broejenz Sound, 80° 20′ north latitude. All were well on board.

SCIENTIFIC NOTES AND NEWS.

We are able to publish as a frontispiece to this issue a portrait of Dr. Edward Orton, President of the American Association for the Advancement of Science, through the courtesy of

Messrs. Munn & Co., publishers of the *Scientific American.*

As is stated elsewhere in this number, Mr. Emerson McMillin, of New York, has generously given $1,000 to the research fund of the American Association. This is especially welcome, as it is now many years since Mrs. Esther Herrman, the only surviving patron, made a similar gift. Mr. McMillin originally sent President Orton $500 to be used by the local committee if needed, and if not to be turned over to the Association. Though in view of their liberal arrangements and entertainments, the expenses of the local committee must have been large, they preferred to pass on the fund to the Association. When Mr. McMillin, who as a member of the Association was present at Columbus, learned that an increase in the research fund was greatly needed he doubled his original gift.

THE British and French Associations for the Advancement of Science will not only interchange visits at the approaching Dover and Boulogne meetings, but there has also been arranged a five days' excursion of members of the British Association through France.

THE British Parliament has sanctioned a grant of £12,000 for a National Physical Laboratory, with an annual appropriation of £4,000, and Mr. R. T. Glazebrook, now Principal of University College, Liverpool, has been appointed director. The establishment of the laboratory is due to action on the part of the British Association.

WE understand that the Boston Public Library will undertake the publication of a card catalogue of physiology, the cards to contain not only the ordinary bibliographical information, but also brief abstracts of the papers. The plan originated in the physiological department of the Harvard Medical School, and Professor W. T. Porter will be responsible for securing or preparing the abstracts.

A NEW regulation on Russian weights and measures was published on August 18th. The current standards are defined in terms of the metric system. The metric system is to be optional, and may be used on a par with the Russian in commerce, in dealing with contracts, accounts, etc., and after mutual agreement by State and municipal authorities. Private persons are, however, to be under no compulsion to use the metric system when dealing with the above-named authorities.

AN International Congress of Physics will be held in connection with the Paris Exposition from the 6th to the 12th of August, 1900. No International Congress of General Physics has yet been held, the present Congress being due to the initiative of the French Society of Physics. The Committee of Organization, of which M. Cornu is President, suggests the following program: (1) reports and discussions on a limited number of subjects arranged in advance, such as 'The definition of units,' 'The bibliography of physics' and 'National laboratories'; (2) visits to the Exposition, laboratories and workshops, and (3) conferences on recent advances. The secretaries of the committee on organization will be glad to receive suggestions in regard to the work of the Congress and will send future programs to those interested. The Secretaries are Ch. Ed. Guillaume, au Pavilon de Breteuil, Sèvres (Seine-et-Oise) and Lucien Poincaré, 105 bis, boulevard Raspail, Paris.

IT is expected that the new lecture hall of the American Musuem of Natural History, with a seating capacity of 1,700, will be ready about November 1st. The exterior of the new east and west wings is also practically completed, but progress on the interior is stopped by complications in city politics through which the payment of appropriations is delayed.

AMBASSADOR WHITE, now at Berlin, General A. W. Greely, Chief of the Signal Service, and Professor Willis L. Moore, Chief of the Weather Bureau, have been appointed delegates from the United States to the International Geographical Congress, meeting in Berlin from September 28th to October 4th.

THE council of the Royal Botanic Society have appointed Mr. James Louis North Curator of the Society's Museum at Regent's Park.

SIGNOR MARCONI, it is said in the daily papers, will visit the United States next month with a view to introducing his methods of wireless telegraphy.

The Upper Italian Council of Health has awarded a fund to Professor Grassi to aid him in continuing his investigations on malaria.

In the last report of the Potsdam astrophysical observatory it is stated that the position of assistant, vacant by the removal of Miss Alice Everett to Vassar College, has been filled by the appointment of Dr. Ludendorf, of the Hamburg observatory. Dr. Eberhard has also been appointed an assistant in the place of Dr. Clemens, who has removed to the Bamberg observatory. Professors Wilsig and Scheiner have been promoted to be observers.

Dr. L. A. Bauer will leave Washington for Europe early in September, on business for the Coast and Geodetic Survey, and is to be away about three months. He will inspect various magnetic observatories, and compare the Coast and Geodetic Survey instruments with observatory standards. He will also attend the Seventh International Geographical Congress, to be held in Berlin, as delegate from the National Geographic Society of Washington.

Messrs. J. A. Fleming and H. W. Vehrenkamp, who graduated this year at the University of Cincinnati, having successfully passed the civil service examination for Aid in the Coast and Geodetic Survey, have been assigned to the Division of Terrestrial Magnetism.

The death is announced of Alph. de Marbaix, professor of zoology and anatomy in the Agricultural Institute at Loewen.

We regret also to record the death of Dr. N. Grote, professor of psychology and philosophy at the University of Moscow and editor of the only Russian journal devoted to these subjects.

Dr. J. B. Hatcher, of the department of zoology and paleontology of Princeton University, has returned from his expedition to Patagonia. We hope to be able to publish shortly an account of the important scientific work accomplished.

Through a chance meeting with a fishing boat a letter has been received from the steamship *Diana* dated July 24th and stating that all were well and that they were expecting to reach Disco and meet Lieutenant Peary on July 30th.

Mr. S. E. Cassino, Boston, announces that he will publish during the present year a new edition of the *Naturalists' Directory*.

The Iron and Steel Institute of Great Britain met at Manchester, beginning on August 16th, Sir William Roberts-Austen occupying the chair.

The American Pharmaceutical Association will meet on September 4th, and the following days at Put-in Bay, Ohio.

The fifth meeting of the French Congress of Medicine opened at Lille on July 28th under the presidency of Professor Grasset, of Montpellier, who delivered an address on medical progress in France in the nineteenth century.

The 12th International Congress of Orientalists will be held this year from October 3d to October 15th, at Rome, under the patronage of the King of Italy. The meetings of the Congress will be held in the buildings of the University of Rome, but the inaugural and closing ceremonies will take place in the Capitol. Members, who may secure tickets from the Treasurer of the University of Rome, can obtain a reduction of fifty per cent. while traveling through France and Italy.

As we have already stated, an International Commercial congress will be held in connection with the Philadelphia Commercial Exposition. It will open on about October 10th, and will include delegates from at least thirty-one foreign governments and 126 foreign chambers of commerce and similar bodies. Many of the topics proposed for discussion are of direct or indirect interest to men of science.

The plague has been so long prevalent in India that it has ceased to attract a considerable share of public attention. The occurrence of cases in Mauritius and Oporto and the suspicion of their presence in Naples and in other cities should, however, not be disregarded. The death of Dr. Müller at Vienna shows that the disease may be highly contagious in spite of the most careful scientific precautions. An epidemic, such as the 'black death' of earlier centuries may be very improbable, but it cannot be regarded as entirely impossible.

A Reuter's telegram announces that the expedition of the Liverpool School of Tropical Diseases, under the direction of Major Ronald Ross, I. M. S., has arrived safely at Freetown, Sierra Leone, all well. Major Nathan, the Acting Governor of the Colony, has written to

Mr. Alfred L. Jones, the Chairman of the School, stating that he will do all he can to assist the expedition, and expressing the hope that one result will be the establishment of a bacteriological laboratory in the colony.

The American word 'scientist' proposed by the late Dr. B. A. Gould is apparently becoming acclimatized in Great Britain. Though *Nature* has stated that the word is excluded from its columns it has occurred in the editorial notes. It will also be found in the *Academy* and in the London *Times*. The latter in the issue of August 15th even uses the word retroactively speaking of 'the great German scientists of the past.' But the best testimony that the word must now be regarded as correct and classical English is the fact that it is to be found in Mr. Thomas Hardy's 'Two on a Tower.'

The issue of *Nature* for August 10th says: "We have received the number for July 21st of our American contemporary Science, which contains an elaborate article by Professor Underwood, headed 'The Royal Botanic Gardens at Kew,' in which the features of the garden and its position as a scientific institution—'its beautiful lawns, its delightful shade, its historic associations, its immense collections of plants, and its wonderful activity in the direction of botanical research'—are described and discussed with critical appreciation *apropos* the recent establishment of the Botanic Garden of New York and its capability to become 'even more influential in democratic America than Kew has become throughout the length and breadth of the Queen's dominions.' It is gratifying to have this acknowledgment of the work of Kew; and the tribute paid to the versatility and ability of Sir William Thiselton-Dyer in promoting its devolopment and widening its influence will be everywhere endorsed. There are some blots on the escutcheon in the eyes of Professor Underwood, but we imagine there are many who will not see with him in all the instances he mentions. The crowding of the museum collections he notes is an apparent blemish, and one we may hope to see removed by the provision of increased room for the exhibition of the specimens. A somewhat jealous comparison of Kew and Berlin as centers of botanical work is a jarring note in the article; and Professor Underwood allows, we fear, German bias to weigh with him in making it, for instance, when he writes, 'the principles of plant distribution are not so thoroughly grasped at Kew as they have been brought out at the German Botanical Garden through the skill of Professor Engler and his associates.' Yet Kew is the home of Sir Joseph Hooker!"

We learn from the London *Times* that the last issue of the Proceedings of the Asiatic Society of Bengal contains a paper by Mr. Oldham, the Superintendent of the Geological Survey of India, on the present system in that country by which every place keeps its own time. Mr. Oldham describes this as a barbarous arrangement, unworthy of a country pretending to civilization. A traveler going from one town to keep an appointment in another must find out how many minutes there is between the times of the two. To some extent a standard time is used, for the railways adopt Madras mean time all over India, and the telegraph department does the same, but the Official Telegraph Guide contains a table of 44 pages giving the difference between local and standard times. The adoption of a single standard time for India would cause inconvenience because of the extent of the empire from east to west; in some places the difference would exceed an hour. This difficulty, Mr. Oldham suggests, would be met by adopting the system in use in Europe and North America of hour zones, by which the region is divided into belts running north and south, each 15° of longitude in width. Over each belt the same time is used, while in belts to the east and west a change of an hour forwards or backwards is made. In India the lines could follow the boundaries of the chief administrative divisions, as is done in the United States, Canada and Russia. After discussing various suggested standards of time, Mr. Oldham recommends the adoption of the hour-zone system, using Greenwich as the starting point. This would give only two different times in India, an eastern time, exactly six hours later than Greenwich time, in use in Bengal, Assam and Burma, and a Western time, exactly five hours later than Greenwich, in use in the rest of India.

The traveller in either group of presidencies or provinces would find the same time in use everywhere, and when he crossed the boundary he would know that the time was an even hour earlier or later according as he was travelling westward or eastward. In practice, in Calcutta all watches would have to be put back six minutes, but, on the other hand, the railway clocks and those in the rest of the town would not show different times. "I have myself," says Mr. Oldham, "recently had to deal with a mass of time records referring to the earthquake of 1897, and found that a large number had to be rejected because it was impossible to ascertain what standard of time had been used, while in many others it was only after a large mass of calculations had been gone through that the relation of observations from different places to each other could be determined." The steps necessary to initiate the changes are stated to be very simple. The first would be to discontinue the 44 pages of variations in the Telegraph Guide, and when local time was no longer obtainable at the telegraph offices standard time would soon come into general use. In the local observatories in the presidency towns the time signals should be converted into Greenwich time; and in all public offices standard time should be used. "If this were done, the experience of other countries has shown that the general public would soon come to adopt the standard time, and having once appreciated its advantages would soon wonder how they had so long endured the old system."

UNIVERSITY AND EDUCATIONAL NEWS.

It is reported that plans are being made for the establishment of a university at Ottawa.

McGill University proposes to erect at the cost of $70,000 a building for its departments of hygiene, pharmacology and medical jurisprudence. In the medical department of this university Dr. T. J. W. Burgess has been appointed professor of mental diseases.

The will of the late Dr. C. J. Stillé, formerly Provost of the University of Pennsylvania, leaves the income of his property to his wife, but on her death the property will be divided equally among Yale University, the Historical Society of Pennsylvania and a Philadelphia Church. The estate is valued at $150,000. The money given to Yale is to be used for undergraduate instruction in history and political science.

Glasgow University has received £10,000 by the will of the late James Brown Thomson, who has bequeathed £80,000 to the educational and benevolent institutions of Glasgow.

In the July intermediate examination of the University of London, for the first time in its history, the number of candidates in science was greater than in arts. It is said that this change in the relative numbers of candidates in the two faculties is attributed to the fact that the demand for science teachers in colleges and schools is now greater than the demand for teachers of classics and mathematics, and that the remuneration of the former is better than that of the latter.

An International Congress of Higher Education will be held at Paris from the 30th of July to the 4th of August, 1900. The committee of organization has decided that the following topics shall be discussed in the general sessions: (1) University extension; (2) measures for the benefit of students; (3) the education of teachers; (4) the place of the university in agricultural, industrial and commercial education; (5) the international relations of universities and their professors; (6) relations between the faculties of laws and of arts. Special sections will be formed for the discussion of: (1) Law, (2) political and social sciences; (3) geography; (4) history and philology; (5) philosophy and related sciences. Tickets of membership cost only 10 francs and may be obtained from M. Larnande at the Sorbonne, Paris.

The Russian authorities seem bent on spreading disaffection among the people. For quite trivial offences the students at the universities and technical schools were imprisoned, and after they had become thoroughly disaffected were dispersed to their homes throughout the country. Now it is announced that students will be punished by compulsory service in the army for from one to three years, which will naturally spread in the most dangerous quarters any revolutionary views they may have formed.

SCIENCE

FRIDAY, SEPTEMBER 8, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE IMPORTANCE AND THE PROMISE IN THE STUDY OF THE DOMESTIC ANIMALS.**

IT is believed that for the advancement of science, no better service can be rendered by those of considerable experience as teachers and investigators than to point out to their younger brethren lines of study and research which are, on the one hand, important, and on the other promising of results. I have, therefore, selected for the subject of this address before the section of zoology a plea for the study of the domestic animals. The young zoologist may rightfully ask the grounds for studying this heterogeneous, greatly modified series of animals. In the first place it must be confessed that for the animal kingdom as a whole it appeals mainly to a single one of the twelve phyla in the animal series given by Parker and Haswell—that is, to the vertebrates. The other eleven phyla—that is, the whole of the invertebrates except the arthropoda—are ignored. I wish to express very clearly and emphatically at the outset that the plea will not be made because the domestic animals seem to me alone worthy of study by zoologists, or that they are in all cases the best possible representatives of their group. It is most earnestly believed, however, that in the whole range of zoology no forms offer a greater reward for the study of the problems of life, especially in the higher groups, than the domestic animals. The importance of the study cannot be overestimated from a purely scientific standpoint, and certainly if the prosperity, happiness and advancement of the human race are put in the count the subject is of transcendent importance.

* Address of the Vice-President and Chairman of Section F, Zoology, of the American Association for the Advancement of Science, Columbus, August 21, 1899.

A glance at the tabular arrangement of the domestic animals will show where they are situated in the animal kingdom. In the great group of Invertebrates the two domesticated species—the Honey-Bee and the Silk-Worm—may be properly compared to minute islands in a great ocean. Among the Vertebrates, on the other hand, the domestic forms are represented in two of the six classes, viz.: in the Birds and Mammals, and where represented are among the most prominent and important members of the various orders:

DOMESTIC INVERTEBRATES.

The Honey-Bee (*Apis mellifica*).
The Silk-Worm (*Bombyx mori*).

DOMESTIC VERTEBRATES.

Class Aves—Birds.

1. **Natatores** { Goose (*Anser cinereus*). Duck (*Anas boschas*). Swan (*Cygnus gibbus*).
2. GRALLATORES—Waders (no domestic forms).
3. **Gallinaceæ** { Hen (*Gallus domesticus*). Turkey (*Meleagris americana*). Peacock (*Pavo cristatus*).
4. **Columbinæ**—Pigeon (*Columba livia*).
5. SCANSORES — Climbers (Parrots, woodpeckers, etc.). (No domestic forms.)
6. **Passeres**—Canary Bird (*Serinus canarius*).
7. RAPTORES—(Formerly the Falcon was in a sense domesticated).
8. **Cursores**—Ostrich (*Struthio camelus*).

Class—Mammalia.

(A) MONOTREMATA (Forms which lay eggs).
(B) MARSUPIALIA (Forms without true placenta).

ORDERS OF PLACENTAL MAMMALS.

1. EDENTATA—Armadillo, sloth, etc.
2. CETACEA—Whale, porpoise, etc.
3. SIRENIA—Manatee and Dugong.
4. **Ungulata** { Horse (*Equus caballus*). Ass (*Equus asinus*). Pig (*Sus scrofa*). Camels { *Camelus dromedarius*. *Camelus bactrianus*. Sheep (*Ovis aries*). Goat (*Capra hircus*). Ox (*Bos taurus*). Elephant (*Elephas indicus*).
5. **Carnivora** { Cat (*Felis domestica*). Dog (*Canis familiaris*).
6. **Rodentia** { Rabbit (*Lepus cuniculus*). Guinea Pig (*Cavia cobaya*).
7. INSECTIVORA—Mole, hedgehog, etc.
8. CHEIROPTERA—Bats.
9. PRIMATES { Monkeys and apes. Man (*Homo sapiens*).

NOTE—In the table of birds the ordinal arrangement is that of Claus. It will be noted that five of the eight orders of birds have domesticated representatives. Among placental mammals three of the nine orders are represented, the order Ungulata containing the larger number and the most important representatives. A few forms in addition to those named in the tables have been, at some time, more or less completely domesticated.

With the personnel of the subject for discussion thus fairly before us, what has been, what is, and what is likely to be the influence of these forms in the rise and progress of knowledge in the broad field of zoology? Or more specifically, (1) What has been and what is likely to be the influence of the study of the domestic animals upon the doctrine of the evolution of organic forms? (2) What has the study of them contributed in comparative anatomy, embryology and physiology? (3) What has been the contribution in hygiene and preventive medicine? (4) And, finally, what should be their influence in theories of heredity and sociology?

If we would realize the value of the Doctrine of Evolution, let us imagine for an instant that this doctrine of 'orderly change' were eliminated from the knowledge of men!

To turn the zoologist back to the old notions of special and independent creation for each species or group of animals, would be like leaving the astronomer only the sun-god, and the angels to direct the planetary movements. No, it is now next to impossible to conceive of zoology struggling to comprehend the animal kingdom without this guiding principle. If similarity of form, color, structure and stages in embryology, function and even diseases are mere coincidences without further meaning, then, indeed, from a scientific standpoint, one

might as well spend his life and thought on Chinese puzzles as upon zoology. But that there is meaning and inspiration in the study of zoology requires no argument from me in this company, for on the altars of of this section still burns the sacred fire kindled by our absent members—Agassiz, Leidy, Cope, Allen, Marsh and a host of others who now 'see as they are seen, and know as they are known.' It is only for me to endeavor to point out some ways in which that study may be most productive.

If the doctrine of evolution has so illuminated the way, given meaning and point to the work which it never had before, it is pertinent to ask, to what are we indebted for the general belief in this doctrine? No better answer can be given than in the words of Darwin himself in the introduction to the 'Origin of Species:' "It is, therefore, of the highest importance to gain a clear insight into the means of modification and coadaptation. At the commencement of my observations it seemed to me probable that a careful study of domesticated animals and cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed; in this and in all other perplexing cases I have invariably found that our knowledge, imperfect though it be, of variation under domestication, afforded the best and safest clue. I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists." In a work published on this side of the Atlantic, the author, Professor L. H. Bailey, a member of our old Section of Biology, boldly faces those who, still doubting, say: "perform this miracle of changing one species into another before our eyes, and we will believe;" and says: "If species are not original entities in nature, then it is useless to quarrel over the origination of them by means of experiment. All we want to know, as a proof of evolution, is whether plants and animals can be profoundly modified by different conditions, and if these modifications tend to persist. Every man before me knows, as a matter of common observation and practice, that this is true of plants. He knows that varieties with the most marked features are passing before him like a panorama. He knows that nearly every plant which has been long cultivated has become so profoundly and irrevocably modified that people are disputing as to what wild species it came from. Consider that we cannot certainly identify the original species of the apple, peach, plum, cherry, orange, lemon, wine grape, sweetpotato, Indian corn, melon, bean, pumpkin, wheat, chrysanthemum, and nearly or quite a hundred other common cultivated plants. It is immaterial whether they are called species or varieties. They are new forms. Some of them are so distinct that they have been made the types of genera. Here is an experiment to prove that evolution is true, worked out upon a scale and with a definiteness of detail which the boldest experimenter could not hope to attain, were he to live a thousand years. The horticulturist is one of the very few men whose distinct business and profession is evolution. He, of all other men, has the experimental proof that species come and go." * * * Almost or quite as strong a statement might be made concerning domestic animals, as stock breeders and fanciers well know. But the more cautious may say, and have said: "This is the work of man's hands; man who ate of the forbidden tree and became like unto the gods, a lesser creator." Well, here again, ages before coming under man's dominion one of the domestic forms gave the final demonstration.

Those who have read the masterly argument of Huxley in the American addresses on evolution, the address of Marsh before the old natural history section of this

Association in 1877, and the address of Osborn before this section in 1893, know well the story. Starting with the generalized, five-toed forms of the basal Eocene in our own country, passing through many modifications and lateral experiments as they may be called, the five-toed form gradually became the four, three, and finally the one-toed modern horse, with its allies, the ass and the zebra. Thus long before the Coast Range was brought forth, while still the eternal hills were young, the primitive horses disported themselves in vast multitudes in our Western Territories; and it is believed that from this contient they passed to Asia, Africa and Europe, only to come back in these latter days to this so-called New World after making the circuit of the entire earth.

Among living forms perhaps no creature aided more in carrying conviction to the mind of Dawin himself, and to countless other people, than the common domestic pigeon. For most of the domestic animals it is usual to bring in a hypothetical, fossil type, so widely have the living forms departed from any living wild types, and so true to the domestic types do the offspring hold; but with the pigeon it is not uncommon that reversions to the parent form occur, and even in the most modified forms reversions occur, so that there is substantial agreement that the parent stock is the wild rock pigeon (*Columba livia*). That there should be reversions in some forms is astounding, for even the number of vertebræ has become changed by domestition.

If, then, this study of domesticated and cultivated forms has thrown so much light upon this great subject of evolution as the method of nature, is there not promise of rich return for future study? And there is need of future study, for only a beginning has yet been made in this great field.

Let us now turn from Evolution to discuss for a few moments the help which the domestic forms have given to Anatomy, Embryology and Physiology.

If one asks of what animals the structure is known in the greatest detail it must undoubtedly be answered that the structure of man has been most thoroughly explored, then come the domestic animals, especially the horse, dog, cat and rabbit. Much of this work was done before the doctrine of evolution illuminated the way and gave meaning to rudiments or vestiges and to homologies. Still it must be said, in truth, that the older zoologists, with a rare insight, discussed large questions of homology, and recognized at bottom the real relationship of many different forms. It was, however, only the philosophical and far-sighted few who did so. The majority of anatomical work was done for its purely practical bearing on medicine and surgery. It thus happened that human anatomy exerted a powerful influence, indeed, so powerful that names were carried over into the invertebrates, for parts which could hardly, by the greatest stretch of imagination, be homologous with the structures in man from which they were named. If there was any relationship it was of function or analogy rather than that fundamental kinship expressed by homology. Thus the legs of a horse and a spider are for the same general purpose. They are analogous, not homologous organs. Therefore, in many cases in the older morphological work one should not be deceived by supposing that there was any real insight into the phylogenetic relationship of the two forms whose parts were similarly named. While there has been a great tendency to designate parts alike which have only a fancied or analogous relationship, there has been a more harmful tendency to ignore real relationships. Only purely practical ends have been too often in view, and the real kinship of forms as little known as cared about.

What is urgently needed at the present time in comparative anatomy, especially that relating to the domestic animals, is a thorough revision in the light of this last half of the 19th century; then the student, whether especially trained in human, veterinary or comparative anatomy, could pass from form to form and far more easily correlate truly homologous parts, because they would bear the same designations; and he would thus be led to see and appreciate the true kinship, although at first sight there might appear to be only unlikeness.

If any one cannot see the force of what has been said, or does not feel any lack in the present conditions, let him think of the different joints in the limbs of man, horse, dog, chicken and honey bee; or let him ask some one who knows the animals well, but is untrained in advanced anatomy. I believe that such an experience would convince any open-minded inquirer that like designations for homologous parts are desirable; and, secondly, he would be filled with increased admiration for the view of organic nature which points out the significance of a real likeness in what appeared in the beginning so utterly diverse. Here then is work which stands ready for the ablest zoologists.

In Embryology and Physiology the domestic animals have always furnished the greatest amount of information, as one can satisfy himself by consulting any treatise upon these subjects, although 'Human Embryology,' 'Human Physiology' may be printed on the title page. Who did not get his start in embryology by studying the development of the chick, the dog, cat, rabbit or guinea pig? And in physiology students are almost equally dependent on the dog and rabbit. What is known in these fields is but a drop in the bucket, and as the domestic animals have contributed the greater part of that drop, so will they be called upon to fill the bucket to the brim. And what a splendid outlook there is at the present time. New discoveries in physics, like the X-rays, make possible advances in physiology. Perfection of technique in microscopy makes advance in embryology possible. Contemplate the opportunity and the promise for a moment. There is not a single treatise in any language which deals adequately with the embryology of the domestic animals, and the only one in English, the only one usually studied by the veterinary student, is hopelessly bad and antiquated. If one glances at the tables showing the zoological position of the different domestic animals he must be impressed with their wide distribution in the animal kingdom and their representative character. What an opportunity is here for work in comparative embryology! It is coming to be felt that the embryology of the present day is very inadequate in that, while it professedly deals with the entire development of the individual, it really devotes its main energy to the earliest stages and to the very beginnings of the organs. The complete ontogeny of the individual must go further than this and trace the development from the ovum through all the life stages to old age and death. It is only among the domesticated forms, in the higher groups at least, that abundant material under complete control, is at command, without very great expense. Abundant material, with full knowledge concerning it, will be required for satisfactory monographs in the future.

For students, material in great amount at a merely nominal cost, and without sacrificing animals especially for the purpose, may be had at every large abattoir; and every village slaughter house wastes more than enough embryological material every year to supply the aspiring young zoologists in its precincts. That this material is being utilized is evident from the admirable papers upon em-

bryological subjects and from the laboratory announcements of Harvard, Johns Hopkins and many other centers for investigation and sound embryological instruction.

It was intimated above that the pressing need of zoology to-day is complete knowledge of some typical forms, such, for example, as are represented by the domestic animals in the avian and mammalian classes. This thorough knowledge is needed rather than more of the bits and patches from the entire animal kingdom. It is certainly true that morphological knowledge at the present day is too much like a crazy quilt. This every investigator finds to his cost when he wishes to carry a research beyond the most elementary stages. What is needed, then, is concentration—complete knowledge, so far as possible, of each form investigated; and this knowledge must compass the entire life cycle. As also stated above, embryology has, and perhaps properly, concerned itself largely with the beginnings of the organisms and their organs. But in so doing the later but no less important changes have been left almost untouched. Ontogenetic development after birth is of the profoundest importance from all biological standpoints. In some ways a knowledge of how the new-born becomes an adult is certainly of profounder interest than how an egg becomes a new-born animal. A few years ago the agricultural experiment stations, especially those of Wisconsin and New York, wished to answer, so far as possible, the question of how to obtain the best nutrition and growth to render animals most satisfactory as food and thus, also, the most profitable in the market.

There arose questions concerning the changes in muscle, if any, in passing from youth to maturity and from maturity to old age; from a condition of leanness to fatness. Here were some very pertinent questions which only a biologist could answer, but at that time many of the questions were enshrouded in darkness. But during the present year several investigations bearing upon these points have been published. Every one knows that the muscles increase in size as well as in strength in a growing animal, and also that they increase in size and strength in an adult if properly exercised. But who would have been prepared to expect that in this increase in power and size of the whole muscle the individual fibers of which it is composed would actually decrease in number? This brings us to the fundamental question of the mechanism and the structural changes by which youth and maturity are merged into old age and decay? If you will read the suggestive address of Dr. Minot given at the Indianapolis meeting in 1890, and the papers of Hodge on the changes in nerve cells from childhood to senility, you will gain a notion of the work to be done upon the post-embryonal ontogeny, and the rewards to be gained by the faithful, clear-brained investigator.

I cannot leave this part of the subject without reminding you again of the brilliant part the paleontology of the horse has played in zoological science, and to express the belief that its embryology, when thoroughly worked out, will play an equally brilliant one. At present this embryology is known only in fragments. Why should there not arise in this boundless western world, in the land where the earliest horses appeared, some embryologist who, with the cheap and abundant material, should work out this problem with completeness? Next to man himself there is probably no animal in which the civilized world is more profoundly interested. To trace in the growing embryo not only its own life history, but to gather as many and clear glimpses as possible of its race history, would, indeed, be an inspiration. Enough

is already known to make one sure that the field is worth working and that the harvest is certain. Almost as much might be said for some of the other domestic animals. And why should not some of this splendid work be done in America? This was the original home of the horse, of representatives of all the groups of domesticated animals, and every summer brings from its boundless treasures ever new and more marvelous forms. I believe that the time will come—indeed, that it is at hand—when zoological science, yes all science in America, will go forward with the giant strides which have already characterized her inventive and industrial history.

So far this address has been practically limited to the higher vertebrates, but I would not remain wholly silent upon the great phyla of invertebrates. The honey-bee and the silkworm should not be passed by without a word. Their history, like that of most of the domestic animals, is shrouded in darkness, but they are still with us, calling forth from each generation renewed interest and admiration. They, too, offer problems for the biologist, and deserve his attention. For example, take that great question of apparent voluntary parthenogenesis with the bees. What is the mechanism by which fertilized eggs become queens or workers and unfertilized eggs become only drones? Is this very general belief really true? If true what are the differences in the course of development in the eggs in the two cases? Then in Physiology what a multitude of problems the bees propound? Why will a special form of food cause an egg to develop into a queen instead of a worker? How can the workers change honey into beeswax? How can a mere blind pouch serve the purposes of digestion and excretion in the larva? For answering all these questions and many others the honey-bee is admirably adapted. One can keep the swarm constantly under his eye, and he can control, so far as necessary, the actions of the bees; there is abundance of material which may be had at all stages of development. Indeed, with the hundreds of thousands, perhaps millions, of insect species yet to discover and describe, and all these questions of structure, function, embryology, transformation, histolysis and redevelopment to answer, it looks as if the entomologist would not be compelled to sit down and sigh for new worlds to conquer for some time yet. And if I may be allowed to carry over my convictions from the vertebrates to the invertebrates, I believe that zoology would be far more advanced if a million or two species of insects were left undescribed and the enthusiasm and devotion of the entomologists—and no class of zoologists are more enthusiastic and devoted—were directed toward the elucidation of the entire life cycles of a few typical forms, and the structure, function and embryology of these were worked out as completely as modern knowledge and method would allow. Then there would be some standards of comparison to facilitate the work on the infinite number of forms still uninvestigated. From the mongraphs on the embryology and morphology of insects which have appeared during the last few years one cannot help feeling that this fascinating field will soon claim a multitude of students, and that none need go away empty-handed.

In Preventive Medicine and Hygiene the domestic animals have, as in so many other fields, served as the basis for study and investigation. To appreciate their importance one has but to recall the fact that at the close of the last century Jenner's application of cowpox as a protection against smallpox has led to an almost complete expulsion of this once dreaded scourge from civilized lands. Or to refer to the memorable investigations of Pasteur begun in 1866 for the amelioration of the condi-

tion of the silk industry of France. He saw and pointed out, with the greatest clearness, the importance of cleanliness, fresh air and good food for the avoidance of degeneration and disease in the silkworms. Are not fresh air, cleanliness and good food the very foundation stones of hygiene for all animal forms? In the silkworms, also, Pasteur found causes for disease in the microscopic organisms which infested their bodies, and in some cases at least this cause appeared to pass from one generation to the next through the eggs. What this study of Pasteur upon the diseases of silkworms, upon anthrax in the domestic mammals upon fermentation, did for surgery is thus expressed by Lister, the recognized father of antiseptic surgery, at the jubilee celebration of Pasteur: "Truly there does not exist in the entire world any individual to whom the medical sciences owe more than they do to you. Your researches on fermentation have thrown a powerful beam which has lighted the baleful darkness of surgery, and has transformed the treatment of wounds from a matter of uncertain and too often disastrous empiricism into a scientific art of sure beneficence. Thanks to you, surgery has undergone a complete revolution, which has deprived it of its terrors and has extended, almost without limit, its efficacious power."

In our own and in other countries what untold loss has come from 'Texas Cattle Fever?' The working-out of the biological relations of that disease, it seems to me, is one of the most brilliant pieces of scientific investigation which has illuminated this truly luminous end of the 19th century. With all the knowledge accumulated since Pasteur's investigations on the silkworm diseases to serve as guides and to give suggestions, it took one of the foremost pathologists which our country has produced (Dr. Theobald Smith) three years to bring the investigation to a demonstration. And little wonder! For instead of the previously known simple relations of microbes to disease, the way was round about and involved two generations of animals and two species. Furthermore, the germ of the disease was not a bacterium or fungus, easy to cultivate on artificial media, but one of the sporozoa for which no artificial culture medium has yet been devised. The story is briefly as follows: Cattle ticks (*Boophilis bovis*) suck the blood of animals in which the Texas-fever germ is present. The germs enter the eggs of the ticks and thus infect the next generation. This new generation of ticks attach themselves to other cattle and introduce into their blood the disease germs which are carried over from a previous generation. And so the mutual infection goes on in a vicious circle from generation to generation. The direct human interest, outside the economic one, which this investigation has is the suggestion and the accumulating proof that malaria in man is transmitted in practically the same manner by mosquitoes. Truly the living hypodermic syringes are to be feared as well as execrated.

Thus hardly a triumph in medicine has been won without substantial aid from the domestic animals, and it is believed by the acutest minds engaged in the great work of ameliorating the sorrows of the world caused by preventable disease and premature death that we are now only on the threshold of discovery. Is not the fact that the discoveries in medicine and hygiene in the past have been so dependent upon the domestic animals sufficient guarantee that future discovery will be likewise dependent upon them; and as human beings are so closely linked with the domestic animals in economics, in hygiene and in promised avoidance of disease, is there not abundant reason why the veterinary profession should be elevated and become a true unit in university life, a close colleague

with the profession of human medicine; and that human medicine in turn should reap even greater good in future by a more thorough appreciation and study of comparative medicine?*

At this time, when the dawn of the 20th century is already in the sky, the biological problem most important to the animals, and to the human race in its aspirations, is the problem of heredity. What is its mechanism, what light does it throw upon the chances for preservation from degradation, and for elevation to exalted manhood? Organic evolution has shown in the clearest manner that 'descent with modification,' in order to meet the requirements of the environment, does not, by any means, signify in all cases what is commonly meant by the term progress. Consider the mental and physical condition of parasites. They have descended literally, and with the profoundest modifications. Look at the serpents and the partly limbless forms of the ocean. In their descent they progressed toward fitness for their environment, fitness to make the most and best of the life they have to lead; but this is not the modification desired in human descent. The Utopia for human society is where there is abundant food for all, congenial labor for all, education and amusement for all, every one to work out in its fullness his own individuality and at the same time serve the common weal. What lessons do the domestic animals give upon this? That 'like produces like' is a generalization believed in by every one, and sufficiently supported by every-day observation. Equally true and general is the statement that 'like produces unlike'—that is, no offspring is exactly like its parents, and no two offspring are exact duplicates. While the race type is persistent, individual modifications are infinite. In this likeness and still unlikeness between offspring and parent is the hope and the despair of mankind. The hope because every horticulturist, every stock breeder and every parent hopes that the offspring will be unlike, but that the unlikeness will be an improvement. The despair because unlikeness is just as liable to take the trend of the undesirable qualities and intensify them. With the lower animals the undesirable modifications may be eliminated, must be eliminated, or the race will deteriorate. In the human family the problem is equally plain, but infinitely more difficult of execution. How can the brood of criminals be avoided and the sturdy and right-minded possess the earth?

If one would see how social theories have worked themselves out successfully the domestic animals again furnish models, models in which theory is no longer theory, but fact under which thousands of generations have lived, flourished and passed away. The most perfect states are found among the social insects, foremost of which are to be mentioned the honey-bee. This society, which man has had under domestication so many thousand years that the beginning has been forgotten, has won the admiration of the world, and poets and philosophers have immortalized it with their words. What could appear more perfect? Each member of the society is apparently free, and each labors for the common good. Truly it seems an ideal state, but to attain this ideal state queens must kill their sisters or be killed by them; thousands must be relegated to ceaseless toil, and kings exist but for a day. This perfect state consists only of a queen-mother and thousands of sexless slaves. All exist, not

* For further discussion of the relations between human and comparative medicine, see for Comparative Medicine, Dr. James Law's address at the inauguration of the New York State Veterinary College, September 24, 1896.—*Veterinary Magazine*, September, 1896. For Human Medicine, see Dr. Charles S. Minot's Yale University Medical Commencement Address, June 29, 1899.—SCIENCE, July 7, 1899.

for their own individual pleasure, improvement or happiness, but only for the community. If socialists will study this and other examples of states which have resolutely worked out the social problems to a successful finish they will perhaps get an inkling of how far off is the realization of all Utopias, of even the noble aspirations of our own National Declaration of Independence. Their realization is far off and difficult or impossible because the struggles of individualism are never compatible with perfect socialism. It is not possible to serve both the state and the individual with one's whole power. If there is partial service, as there must be in human society, neither the state nor the individual will have the most perfect development. The parallelogram of forces will give a resultant to be sure, but so far this resultant has proved a tortuous and unsatisfactory line instead of the perfect form of beauty dreamed of by the enthusiasts. *

In this brief review I have tried to show a few ways in which the study of domestic animals has thrown light on the problems confronting mankind in his social ideals, in preventive medicine, in physiology and hygiene, in embryology and comparative anatomy and in the doctrine of the evolution of organic forms. The attempt has been made to show that, with the higher forms at least, that is the forms most closely related to man, and with whose destiny his own economic, hygienic and social relations are most closely interwoven, the domestic animals have in the past and promise in the future to serve the best purpose because of the abundance of the material in quite widely separated groups of animals which long have been and still are under greatly differing conditions and surroundings; and, finally, because this material is plentiful and under control, and thus may be studied throughout the entire life cycle.

If any one is repelled from the study of domestic animals because they have been greatly modified by their so-called artificial surroundings in the company of man, I would remind him that man is also a part of nature, and that the modifications due to his action simply illustrate, in a somewhat definite and determinable degree, the plasticity of the forms under his control, and thus give the clearest and most undeniable proof of the capability of change in response to environment and selection. Furthermore, any wild form chosen for investigation has likewise departed widely from its primitive state, under the stress of changed and changing environment and a selection somewhat different but none the less severe. It is also contended that the knowledge of the environment of these domestic members of the zoological family for so long a time has been of the utmost help to many of the ablest workers, as one can infer from the quotation from Darwin in the earlier part of this address. There has been and still is too great a tendency in biology to study forms remote and inaccessible. This is, perhaps, partly due to the fascination of the unknown and the distant, and the natural depreciation of what is at hand. But study of these supposedly generalized types has proved more or less disappointing. No forms now living are truly primitive and generalized throughout. They may be in parts, but in parts only. The stress of countless ages has compelled them to adjust themselves to their changing environment, to specialize in some directions so far that the clue through them to the truly primitive type is very much tangled or often wholly lost. Indeed, every group is in some features

* The reader who is interested in sociology is advised to read the admirable articles of Mrs. Anna Botsford Comstock on Insect Socialism in *The Chautauquan* for 1898, Nos. 4, 5 and 6; also Shaler's 'Domesticated Animals,' for their influence in civilization.

primitive. Even man himself is one of the best forms to study the limbs upon. As expressed by one of my colleagues (J. H. Comstock) in his papers upon phylogeny, the unraveling of the mysteries of 'descent with modification' in their entirety cannot be worked out in a single form or group; the puzzle must be spelled out part by part, and one group will serve best for one organ and another for another.

As any complete study requires much material at all stages the higher forms must be of the domesticated groups, or wild forms must be practically domesticated for the time being to supply the material.

It may be objected, also, that in the investigation of domesticated forms sordid interests will play too prominent a part. No doubt, to the true scientific man the study of zoology for its own sake, that is for an insight into the fundamental laws of life, is a sufficient incentive and reward. Judging from the past, the study of the domestic animals in any other way than in a scientific spirit and by the scientific method will prove barren, but studied in that spirit and by that method the result has always justified the effort, and has thrown as much, if not more, light upon biological problems than an equally exact study of a wild form.

Therefore, while purely practical ends can never supply the inspiration to true scientific work, still surely no scientific man could feel anything but happiness that his work had in some ways added to the sum of human well being. Perhaps no one has expressed so well the sympathy of a scientific man with his fellow men as Pasteur in the preface to his work on the silkworm diseases: "Although I devoted nearly five consecutive years to the laborious experimental researches which have affected my health, I am glad that I undertook them. * * The results which I have obtained are perhaps less brilliant than those which I might have anticipated from researches pursued in the field of pure science, but I have the satisfaction of having served my country in endeavoring, to the best of my ability, to discover a remedy for great misery. It is to the honor of a scientific man that he values discoveries which at their birth can only obtain the esteem of his equals, far above those which at once conquer the favor of the crowd by the immediate utility of their application; but in the presence of misfortune it is equally an honor to sacrifice everything in the endeavor to relieve it. Perhaps, also, I may have given young investigators the salutary example of lengthy labors bestowed upon a difficult and ungrateful subject."

As a final word, let me summarize this address by saying: However necessary and desirable it may have been in the past that the main energy of zoologists should be employed in the description of new species and in the making of fragmentary observations upon the habits, structure and embryology of a multitude of forms, I firmly believe that necessity or even desirability has long since passed away, and that for the advancement of zoological science the work of surpassing importance confronting us is the thorough investigation of a few forms from the ovum to youth, maturity and old age. And I also firmly believe that, whenever available, the greatest good to science, and thus to mankind, will result from a selection of domesticated forms for these thorough investigations.*

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* If the young zoologist wishes to get a clear notion of the meaning and value of 'species' in modern biology he is recommended to read Dr. Farlow's address in last year's Proceedings; also Dr. D. S. Jordan's 'Kinship of Life' in his 'Footnotes on Evolution,' and Professor Bailey's chapter on 'Experimental Evolution Amongst Plants' in his book on the 'Survival of the Unlike.'

*THE PROGRESS AND PROBLEMS OF PLANT PHYSIOLOGY.**

There are some subjects of whose content and extent most educated people have fairly accurate conceptions, though they may not appreciate the significance of the numerous problems which those who carry forward research are attacking. Literature and history number their appreciative amateurs by thousands. Even such sciences as astronomy and chemistry receive a fair measure of popular approbation and are widely appreciated.

Unhappily this is not yet the case with botany. By even the limited number who think they know of what it treats, it is frequently misunderstood and consequently undervalued. To most mature people it is hardly more than a name for a dilettantish dissecting of flowers, for which an apprenticeship of memorizing troublesome technical terms must needs be served.

It is easy to discover why this is so. It has resulted from the mistaken ways of presenting the subject to elementary pupils. But the difficulty of correcting the misapprehension is not decreased by a knowledge of the way in which it has arisen. We can only rely upon the gradual substitution of better ideas in the newer generation by means of more adequate instruction, and on the occasional popular presentation of more accurate information. For the former we may look to the schools, which are rapidly changing the scope of their teachings. The latter, however, should be undertaken by specialists, as a matter both of duty and of privilege. Popular accounts of plant phenomena may be accurate without being dull, interesting without being sensational, and attractive without being sentimental. But we can expect these characteristics only in properly qualified writers whose scientific training has been sufficient to kindle their enthusiasms and quicken their energies—without spoiling their English. Such books, in considerable number, have been appearing lately from American writers. May their tribe increase! As books of this kind are multiplied we may hope for an increasing appreciation of the science of botany both educationally and economically.

When the general subject has been so misapprehended, what can be expected regarding one division of it? The experimental study of the physiology of plants is not new. Hales more than a century ago carried out such accurate experiments that they are quoted to-day. But even to fairly-educated people the word physiology, conjoined with plant, conveys no definite idea. 'Physiology' we studied at school; is it not that hybrid of human anatomy and hygiene, with barely enough real physiology to salt it, which is inflicted upon immature youngsters, to the accompaniment of lurid lithographs of an inebriate's stomach? But what can 'physiology' have to do with plants that have no teeth to decay, stomachs to ulcerate, or eyes to become myopic? And so it comes about that one must explain to the average man that plants are really alive, that they work and rest, that they are sensitive to what goes on around them, and that they have established relations with their plant and animal neighbors. How they do these things and how their activities underlie those of all other living beings, even man's, lies within the compass of this branch of the science of botany.

But to such a company as this it is not necessary to set forth in detail the province of plant physiology or to justify its rapid introduction into institutions of higher learning. While Cæsalpino and the schoolmen argued vainly about the location of the 'soul' of plants, it was the growing

* Address of the Vice-President and Chairman of Section G, Botany, of the American Association for the Advancement of Science, Columbus, August 21, 1899.

dissatisfaction with the empty reasonings of such scholastic philosophy that drove men to observe the phenomena of nature. Thus real physiology had its birth in the last half of the seventeenth century, only a little later than the other natural sciences. It is, however, only in comparatively recent years that plant physiology has become established upon a firm experimental basis and thus fitted to take its proper place among the sciences offered in university curricula. Its real and vigorous growth has been measured by scarcely four decades. Among the countless results of the rejuvenation of biology wrought by various cooperating causes about the year 1860, may be enumerated the rise of plant physiology. One of the first evidences of this renascence was the publication in 1865 of Sachs's *Handbuch der Experimental-Physiologie*, the first volume which gave any comprehensive and clear view of the phenomena of plant life.

From that day to this, with increasing vigor, Sachs's countrymen have been prosecuting researches into plant doings and guiding many students in their maiden investigations. French, Austrian, Italian and Russian students have also made notable advances. On the continent a few great centers of physiological research have been developed, like Würzburg, Tübingen, Leipzig, Bonn, Berlin, Vienna, Prag and Paris. Great Britain has made a notable beginning at three of her great university centers.

But in this country the specialization which alone makes possible the effective development of a subject, has been slower in coming, and it is scarcely a decade since physiology began to have any considerable attention. Five years ago (I speak by the card) one could count on the fingers of one hand the colleges which offered any but brief lecture courses in plant physiology, and the number giving even lecture courses was less than 4% of the total number of colleges. I am sure that many in this audience would be surprised were I to recite the long list of prominent institutions which gave no physiological courses—*some even no botany*. In late years many have made a beginning in the way of demonstration and lecture courses, but the number with even fairly equipped physiological laboratories is still few. Indeed, there are to-day not twenty-five institutions of higher learning in the United States which offer laboratory instruction in plant physiology, even in an elementary way, and still fewer which give opportunity for as much as a year's work. Graduate work in physiology, if the Graduate Handbook for 1898–9 may be relied upon, is now offered only at Barnard, Chicago, Columbia, Harvard, Michigan, Minnesota and Pennsylvania.

The development of centers of physiological research is therefore a matter of the future. It cannot be long delayed, however, for there is noteworthy energy in the advancement of this subject in several of the stronger institutions.

To the professional botanists, who are especially concerned in the advancement of the science, it would doubtless be of some interest should I take this opportunity to recapitulate the investigations which have been most fruitful of progress in the past decade. But the field is so vast, and work is being so vigorously prosecuted, that I should despair of being able, within the limits custom sets, to present adequately the march of our knowledge of plants within the last decade. To such a task, moreover, my own knowledge would be wholly inadequate.

Therefore, instead of presenting a summary of so extensive an investigation, I choose rather to confine my attention to the physiological aspects of botany, and in this field to endeavor to bring before you a conception of the general *trend* of investigation, without any endeavor to mention the work of individuals or even the important isolated

researches which may be the starting points of new lines of progress. At the same time I shall seek to indicate what I conceive to be fruitful lines of study and shall direct attention to some of the unsolved problems which still confront the physiologist.

PHYSICAL CHEMISTRY.

The physiologist is dealing with material phenomena as manifested by living things. Physiology is, therefore, chiefly the application of the knowledge of chemistry and physics to the phenomena of life. It follows that the physiologist must be familiar with the laws deduced by chemists and physicists from their study of matter which is not under the influence of life. He needs to be equipped with the best physical and chemical knowledge of the day. Because of a want of such training reproach has often fallen upon physiology in the past. Inattention to these underlying sciences has led to divers fantastic explanations of phenomena—explanations forbidden by the fundamental facts of chemistry and physics. Compelled thus to rely on advance in other sciences for the possibility of progress in their own, physiologists welcome with the brightest anticipations the rapid growth and development of that field in which chemistry and physics merge—physical chemistry. There is much, it is true, with which its students concern themselves that does not touch directly the activities of plants. But some of its subjects are of the most intimate concern to physiologists.

Solutions.—This is notably the case with the comparatively recent coordination of long known facts and late discoveries into clear and definite laws of solutions. In no condition, outside and inside the plant body, does matter play a more important physiological rôle than in a state of solution in water. The prevalence of a cellulose wall, jacketing the protoplasm of their cells, is probably the most characteristic mark of plants. This membrane precludes the entrance into the body of any substance not in solution, whether originally solid or gaseous. Thus the behavior of solutions is of fundamental importance for the absorption of foods by the colorless plants and of the raw materials out of which the green plants can make foods.

The cellulose wall has been adapted by plants to subserve a function unknown in the animal body, namely, turgor. Only a knowledge of solutions enables us in a measure to understand the existence and regulation of turgor. The solutions enclosed by the semipermeable protoplasmic membrane of the living cell are rarely or never the same as those outside the plant or in paths of water conduction. Such a condition establishes at once a movement of water into the cell and develops a definite amount of hydrostatic pressure, equivalent to the osmotic pressure of the dissolved substances. Thus, by a figure, it is said that the osmotic pressure of the internal solutions pushes outward the protoplasm, backed by resistant but elastic wall, which stretches until its elastic resistance balances the osmotic pressure. If the cell be one of a group the cohesion and turgidity of the cells surrounding any one resist its enlargement. Thus all the cells of a turgid mass of tissue bear firmly against one another, and this condition is of great importance in maintaining the form of young parts in which as yet no mechanical tissues exist. Turgor has its influence also in regulating the diffusion of water vapor through the stomata, in transfusing liquid water through water glands, in certain forms of secretion, and so on. So important is turgor that special salts seem to be provided to maintain it at a normal point. Its relations to growth also are unquestionably of prime importance, but we are not able at present to interpret these relations satisfactorily. Although the statement is

generally made that turgidity is a prerequisite for growth and regulates it, there are some strong reasons for thinking that the relation is rather the reverse, and that growth regulates turgor.

Pathological changes may also be brought about by abnormally high osmotic pressure, a notable instance being furnished by œdema of various organs, especially leaves. In such a case, turgor seems to distend the cell walls extraordinarily, and to act as a stimulus on growth, causing a local hypertrophy characterized by bladdery tissues.

For interpreting all these processes, most fundamental for nutrition and growth, the new knowledge of solutions furnishes invaluable aid. This theory, developed mainly within the last decade by the labors of Pfeffer, Van t'Hoff, Arrhenius, Ostwald, Raoult, and others, looks upon a substance in solution in water as essentially a gas. Its molecules are freer to move than they are in the solid state because of their relations to the molecules of water. These, at the same time that they make mobility possible, obstruct the movements of the solute, so that the molecules of the latter are not nearly so free to move as the molecules of a gas. Thus enormous pressures are necessary to move the solute through the solvent or to remove its molecules from it. Many demonstrations establish firmly the fact that the molecules of solutes exhibit the well-known laws of gases. This general applicability of the fundamental laws of gases to solutes has made evident the proper basis of comparison between solutions of different compounds. For many years, and for some years after a proper knowledge of physical chemistry would have led to their abandonment as not comparable, physiologists were comparing the physiological action of percentage solutions or solutions of definite specific gravity, in ignorance that this was like comparing the action of one gas at atmospheric pressure with that of another at 10 atmospheres pressure. Henceforth, we must deal with equi-molecular solutions if a comparative knowledge of physiological action is sought.

A further study of the behavior of solutions has made us acquainted with the fact that when water solutions which conduct electricity, *i. e.*, electrolytes, are of less than a certain concentration, the solute undergoes partial dissociation, no longer existing alone as a definite chemical compound. A certain amount, depending on the concentration of the solution, is broken up into electrically charged part molecules or ions, which behave osmotically as molecules and increase the osmotic pressure of the solute. Moreover these ions exert a very marked physiological effect upon the protoplasm. Certain ions are extremely injurious, inhibiting the activity of the protoplasm and resulting in death. Poisons, so called, produce a similar result. It is possible that by a study of ionic action we may obtain a more accurate idea of what actually happens when living matter dies by 'poison.' It would be surprising were there not a considerable diversity in the actual effects of various 'poisonous' agents.

Again, certain ions have a less marked physiological action, which is designated as stimulation, calling forth corresponding change in the activity of the protoplasm. Unquestionably many of the peculiarities of growth and development of an organism are responses to the action of ionic stimuli, but of these practically nothing is yet known. Certain human sensations have already been shown by Kahlenberg in his investigations on taste to be due solely to the action of definite H and OH ions. In no organisms is there so good an opportunity as among plants to determine precisely how these factors, always acting in complex combinations, effect the modifications of form and function that constitute adaptation to external conditions.

Studies of this kind have barely begun. Kahlenberg and True were the first to establish the poisonous action of ionic hydrogen in solutions of certain acids and salts. A few other observers have attacked similar problems, but the field is hardly yet explored; it has not been at all cultivated. The relations are complex, it is true, and their unraveling will not be easy; but surely there are rich harvests for the patient worker.

In the light of the modern theory of solutions, it is essential that the whole field of root absorption be reexamined. Dilute solutions of the soil must surely be electrolytically dissociated in large measure, and this fact doubtless stands in intimate relation to the entrance of solutes into the plant. In the absence, at present, of complete experimental demonstration of the behavior of these substances, we are compelled to rely largely upon theoretical probabilities. Interesting possibilities, however, present themselves to the speculative worker and point out various directions in which investigation may be fruitful.

Energy.—One of the directions in which physical knowledge is now extending, but in which it is still so imperfect as to leave much to be desired, is in the understanding of the forms and transformations of energy. But the physiology of plants has not yet made use of all the knowledge that is available in this direction. Though in the past decade we have had some important researches, there yet remain great gaps in our knowledge of the income of energy to the plant and of the ways in which it is utilized. I may here indicate only a few of these gaps in our knowledge.

While it is easy to calculate the potential energy of the foods absorbed it is not easy to determine how much of the energy is available, in what form it is released and what changes it undergoes, as it is used by the plant.

We know that heat is one form of energy which is constantly affecting the organism, and we speak of certain temperature limits as one of the essential conditions for life. But what does that mean? Why is it a condition of life? Is it merely because the necessary chemical changes can only occur within certain limits? If so, what does *this* mean? Does it mean that the radiant energy which imparts to us the sensation of heat must be acting upon the molecules of the various chemical compounds ere they are capable of enough lability to afford the living protoplasm opportunity to push them over, so that they fall into simpler compounds, or to lift them to a higher level of complexity and to greater instability? If heat does not merely increase chemical instability, is life possible within certain limits of temperature because there is pouring into the organism a supply of energy which the protoplasm may utilize in directer fashion to do the work necessary to existence?

What is the source of energy for the colorless plants which assimilate the simpler foods? It is almost inconceivable that they can produce proteids out of the carbohydrate and nitrogen compounds with which they can be supplied without needing a considerable amount of energy besides the potential energy which reaches them in the foods they absorb. If there is no direct supply of radiant energy, it looks very much as though these plants had acquired the long-sought power of lifting themselves by their own boot straps. Yet if radiant energy, either as light or heat, is utilized by them, we know nothing of it at present. Or is it the energy of the O_2 absorbed for respiration which accounts for the extra work done? The data are not at hand to determine the correct answer to these questions. General statements abound, and to many it may seem that all this is known, since it is often dogmatically settled in text-books. Yet in reality we must have

exact measurements of the amounts of energy involved—a thing not yet accomplished—before we can be said really to know whence plants derive their energy and what heat means for them.

Even the case of the green plants is not at all clear. That they construct their own food in great measure is certainly true. That they do this by using absorbed radiant energy of the quality which gives us the sensation *light* is well known. But it is by no means clear, in terms of chemistry and physics, how this is done, or even what measure of the absorbed energy is utilized. Measurement, indeed, is difficult, yet quantitative results are necessary before we can be satisfied that we know what is happening when the leaf makes food.

Finally it may be said that little is yet known of the energy relations in the processes of growth. Here, since we must deal wholly with internal release and utilization of energy, investigation will be most difficult and uncertain.

Stereochemistry.—The decade that is passing has witnessed the very great extension of chemical knowledge in the direction of the constitution of the molecules of carbon compounds. Stereochemistry touches plant life most obviously in its relation to the carbohydrates, which are constructed by the green plants, and digested and utilized by all. The phenomenal work of Fischer on the sugars, supplemented as it has been by that of Tollens, Kiliani, Lobry de Bruyn and others on asymmetric carbon atoms, has put us in possession of facts which throw a flood of light upon nutrition and are destined when more completely exploited and fully applied, to elucidate many difficulties in our present thinking about the feeding of plants.

We have learned for example that a carbon compound, to be a valuable food, must not only contain C, H and O, but that these must be combined in a particular fashion. The aldehyde group CHO, the ketone group CO, and the radical CH_2OH are characteristic of good foods. The simpler sugars such as glycerose and arabinose; the hexoses, glucose or grape sugar, fructose, or fruit sugar, mannose and galactose; the polysaccharides, sucrose or cane sugar, lactose or milk sugar, and maltose or malt sugar are all substances which have been proved useful as plant foods, and all contain one or more of these groups.

Up to a certain limit, the presence of a particular molecular group increases the food value. What does this phrase 'food value' mean? Does food value depend solely on availability of energy, *i. e.*, the ease with which it can be released? Or has the form in which energy is set free something to do with its availability and the consequent food value? Or does the constitution of the molecules before and after decomposition affect food value? If so, is it because the constitution of the molecules is related to the form in which energy is released or because it is related to the ease with which energy is released?

When the complex carbohydrates like starch and inulin are to be utilized, they break down through a series of dextrins and levulins respectively, finally becoming simplified to hexose sugars. Why is this necessary? And how are we to interpret these decompositions? Are they part of the energy-release? It can hardly be doubted that the constitution of the molecules of starch and inulin, composed as they are of units of glucose and fructose, determines the permanence while in the storage form, and that separation into their constituent units in digestion makes possible the assimilation of the sugars as food. It is plain, therefore, that a precise knowledge of the constitution of starch and inulin is a desideratum. We must look forward also to further extension of stereochemical knowledge of the almost infinite variety of

the other carbon compounds and to the investigation of the nitrogenous substances, as yet scarcely well begun. These may be expected to put physiologists into possession of valuable clues to the secrets of nutrition and respiration.

How intimate this relation between the arrangement of atoms in space and physiological activity is, is to be seen in the fact that fermentability is dependent upon the configuration of the sugar molecule. It has been found that, of the many sugars known, only those with 3, 6, or 9 atoms of carbon in the molecules are fermentable. Thus the triose sugar, glycerose, whose formula is $C_3H_6O_3$, is fermentable, while the tetrose sugar, erythrose, $C_4H_8O_4$, and the pentoses, ribose, lyxose, xylose, and arabinose, $C_5H_{10}O_5$, are not. In like manner several of the hexoses, $C_6H_{12}O_6$, and the nonnoses, $C_9H_{18}O_9$, are fermentable, while the intermediate ones, such as the heptoses, $C_7H_{14}O_7$, are not.

But the relation is yet more intimate. Even when the proper number of atoms is present they may be arranged in such a fashion as not to be open to disturbance by an organism.

Thus, certain species of yeast are capable of fermenting *d*-glucose, *d*-mannose, and *d*-galactose. The arrangement of their molecules may be represented in a plane as follows:

$$d\text{-glucose} = CH_2OH-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}H\\C\\OH\end{array}-COH$$

$$d\text{-mannose} = CH_2OH-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}OH\\C\\H\end{array}-COH$$

$$d\text{-galactose} = CH_2OH-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}H\\C\\OH\end{array}-COH$$

But *d*-talose, whose structure is the following:

$$CH_2OH-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}OH\\C\\H\end{array}-COH$$

cannot be fermented by these yeasts. Inspection shows that *d*-talose differs from *d*-galactose and *d*-mannose only in the transposition of the molecular groups about a single one of the asymmetric carbon atoms, and from *d*-glucose only in the transposition about two carbon atoms.

Again, while *d*-glucose,

$$CH_2OH-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}H\\C\\OH\end{array}-COH,$$

is fermentable, its isomer, *l*-galactose

$$CH_2OH-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}OH\\C\\H\end{array}-\begin{array}{c}H\\C\\OH\end{array}-\begin{array}{c}OH\\C\\H\end{array}-COH,$$

is not at all fermentable.

The discovery that yeasts, long believed to show direct ferment action of the protoplasm, produce the chemical changes known as fermentation by the intervention of enzymes, removes the problem from the immediate field of physiology, only to group it with the host of baffling catalytic phenomena which the chemist is at present wholly unable to explain. Thus all fermentations at present known become closely associated with the digestive processes in nutrition. We may scarcely expect light upon all these phenomena until the preparation of the enzymes in a state of purity is attained. This, it is to be hoped, will be followed by a knowledge of their composition, though, as they now appear to belong to the group of nucleo-proteids, this may only be ascertained when the long-awaited desideratum is attained and we know the composition of proteids themselves.

The action of the enzymes, which is limited by the molecular constitution of the substances they hydrolyze and break up, is

probably dependent upon their own constitution. Fischer's researches seem to show that the molecular relation between the two are as intimate as those between a key and the lock whose wards it must fit before the position of the parts can be altered. If this proves to be true, we shall look for a better understanding of the processes of digestion with the further extension of the stereochemistry of the nitrogen compounds.

Again a knowledge of the physiological action of definite radicles, which may differ according to their position in the molecule, is being reached by determining the effect of the introduction of a certain radicle or of a change in its position. The ability to alter chemical structure at will by known reactions puts it into our power to ascertain how each change affects the protoplasm. Thus in the phenols, a series of compounds allied to the tertiary alcohols, of which the so-called 'carbolic acid' is a familiar example, True and Hunkel find that the introduction of the nitro group (NO_2) or the methyl group (CH_3) into the benzene nucleus increases the poisonous effect, while an increase in the number of hydroxyl groups (OH) or nitro groups (NO_2) has little or no effect.

PHYSIOLOGICAL MORPHOLOGY.

Within the past decade attention has been especially directed to the causes which affect the development of plants and determine both form and structure. A moment's thought suffices to impress upon any one the fact that a great number and extreme variety of external agents are acting and interacting in most complex fashion upon all plants. Some of the more obvious of these groups of external causes are even popularly recognized. Thus one hears it said that poor soil and scanty water is the cause of the dwarfing of plants, which under better conditions attain a greater stature.

Such apparently obvious deductions may be correct, or may not be, but satisfactory and accurate analysis of the effects of external agents is a problem of the utmost difficulty, because it is well-nigh impossible to alter experimentally one condition without really altering others at the same time. The solution of the problems of physiological morphology is, therefore, only to be attained by the most assiduous care in experiment and induction.

Morphology.—In illustration of these problems I may refer to the recent studies made by Klebs on the external factors which control various reproductive processes among the algæ. By experimental analysis he has sought to determine the bearing of light, temperature, density of medium, and various other agents upon the production of zoospores and gametes. These studies have shown that it is possible to call forth a definite and very complicated physiological process, of far-reaching consequences, by appropriate changes in the environment. How they operate remains yet to be explained.

In the higher plants the investigations of Goebel and many others have shown the possibility of controlling growth and development in a similar way and to a remarkable extent. The relation between the different members of a plant has also been exploited, largely within the past decade, although its beginnings were long ago. The study of correlations has cast much light upon the causes of form, and has made more impressive than ever the wonderful plasticity of plants.

Correlations. — Qualitative correlations, particularly, offer an inviting though difficult field for investigation. I need only mention a few examples of such correlations. Upon the removal of the terminal shoot of a pine, one or more of the lateral shoots erect themselves and undergo appropriate changes in mode of internal growth

and development, acquiring radial structure instead of dorsiventral, and branching on all sides instead of on the flanks. The transformation of sporophylls to foliage leaves following the removal of normal foliage has been a long-known example, to which renewed attention has been directed by the fine illustration of such change obtained in the experiments of Professor G F. Atkinson. It was shown by Knight nearly a century ago that the subterranean shoots of the potato, upon removal of the aerial parts, rise above ground and develop ordinary foliage leaves and flowers instead of tubers; while, conversely, the enclosing of aerial shoots in a dark chamber with saturated air gave occasion for the development of tubers, a phenomenon which is not uncommon under other than experimental conditions. A large number of similar transformations are now known.

Besides the accumulation of a greater range of such phenomena, we must look to the future for a luminous theory of this reciprocal influence of organs. At present there is little that is satisfactory in the discussion of the nature of correlation. In what conceivable way can the removal of one member act upon other parts so as to alter the course of its normal development? What can be the nature of the stimulus which overcomes the diageotropism of the horizontal subterranean branches of the potato, and induces upright growth and the development of foliage?

Regarding the quantitative correlations we are quite as much in the dark; perhaps more so, because of the relation of other functions. It is now clear that the greatly enlarged leaves and stems which develop after decapitation of a tree are in some way due to the increased food supply. But in what relation does the supply of food stand to these growths? Is the extensive removal of parts alone the stimulus which determines the revival of dormant buds and the formation of adventitious buds? Or does the increased amount of food act as the stimulus? But our present view of the movements of foods is that it is due to removal from solution, at the point where they are being used, of the substances which are needed. The using of food, indeed, is looked upon as both actuating and regulating, in large measure, the movement of food to any point. How, then, consonant with these ideas, can a superfluity of food occur at any point, there to act as a stimulus? Or how can excess of food in any way determine the increased *use* of food and so accelerate the growth of parts?

Pathology.—Closely connected with the study of the normal activities of plants are disturbances in the rate and character of function which are properly included under the term pathology. During the past decade very rapid advance has been made in a study of those pathological changes which are due to the presence of a foreign organism. Indeed, the phrase 'diseases of plants' calls to mind almost exclusively the effects of parasites, which cause wilting by mechanical stoppage of water supply, extraordinary growths in the form of tumors, destruction of chlorophyll to the detriment of photosynthesis, and a host of other evident changes. Indeed, as compared with other fields, we are tempted to say that this has been over-cultivated. The difficulty, however, is not so much in over-investigation as in over-publication regarding the distribution of the diseases and the application of palliatives and remedies. This is, in a measure, justified by the enormous economic value of the crops attacked. But one cannot help wishing that the staffs of our experiment stations particularly would give greater attention to investigations on the nature of diseased conditions than to repeating again and again the study of remedial operations.

There is thus one phase of pathology which has yet been comparatively neglected. The presence of a definite organism, whose activities clash with those of the host to the injury or death of the latter, is in itself an incitement to investigation. But we need also knowledge of those disturbed functions whose causes are dependent on other stimuli than the presence of a parasite. Some of these are doubtless internal and may long remain obscure, even as the causes of the so-called 'spontaneous' movements have hitherto eluded observation. But unquestionably many plant diseases are due to untoward conditions of the environment, working sometimes through chemical, sometimes through mechanical, sometimes through ethereal stimuli. This sort of work has been vigorously undertaken by the Division of Vegetable Physiology and Pathology at Washington, with full consciousness of the fact that, in order to attain results of value, there must be a fuller and more accurate knowledge of the normal processes.

At this point we are confronted by the difficulty of determining what processes are normal and what are pathological. It is the old question of sanity and insanity in a new guise—a question which each is tempted to answer in the same way as the old Quaker, who remarked to his wife: "Wife, they're all daft but thee and me; yea, and sometimes I think *thee* seems a little queer." What action shall be chosen as a norm is a matter of judgment, the general vigor of the plant alone serving as an imperfect criterion; imperfect, because we do not always know what constitutes vigor. Thus the study of pathology needs not only the examination of parasitic diseases, but also a wide acquaintance with the proper activities of healthy plants in order to determine what derangements are produced in them by untoward circumstances and obscurer internal causes. In the latter is an almost unworked field which promises rich reward for patient investigation, and that not only for the sake of pure science, but also for applied physiology as well.

If parasitic diseases cause among cultivated plants a loss of millions annually, is it unlikely that factors which can be controlled, if it is worth while to do it, cause in our crops a shortage whose money value may be many fold greater? There are already practical experiments tending to show that most of our field and garden crops steadily suffer for want of water, a want which windmills and water-driven electric pumps might often supply to great profit. We may not guess; we must *know* by experiments on a large scale whether or not it will pay to supply water and to control other unfavorable conditions, before we dare recommend such measures to a practical world.

IRRITABILITY.

I must now turn to a topic which is really deeply involved in all that I have already discussed, but one that deserves special mention. I mean the relation of irritability to the well being of plants. Seventeen years ago Sachs wrote: "Irritability is universal in the vegetable kingdom . . . Vegetable life without irritability is just as inconceivable as animal life without irritability. Irritability is the great distinguishing characteristic of living organisms; the dead organism is dead simply because it has lost its irritability."

It would be impossible to state the case more strongly. But it is one thing for him who has conceived a truth to state it clearly, and quite another thing to have this truth enter into the thinking and the experimenting of investigators. Long after the clear annunciation of the importance of irritability by the great physiologist—the father of modern plant physiology—too many were finding the chief rôle of irritability in those reactions which by deform-

ing the body moved the connected parts. Plant movements, especially those due to changes of turgor, were long looked upon as the main evidence of irritability in plants. This conception was reflected in the textbooks of the older day and still survives in many of the more elementary works.

After the bearing of irritability on movements was firmly established, it came to be seen that the regulation of the rate of growth and its resumption by certain parts which had ceased to grow was accomplished through irritability. Growth, therefore, as well as movement, had important relations to irritability. But during the past decade, particularly, a better conception has been taking possession of physiological students. It is now perceived that *all* protoplasmic functions are initiated or controlled by external physical or chemical agents. This point of view is reflected in that masterly treatise of Pfeffer, the second edition of his *Pflanzen-physiologie.* Throughout the first volume, discussing the physical and chemical phenomena connected with metabolism, the ability of the protoplasm to regulate its own operations and to control even the physical changes in adjacent parts is everywhere presented and insisted upon.

The idea of a stimulus, instead of being confined, as it once was, to the action of heat, gravity and moisture, has now been greatly extended. Any external or internal change, slight or profound, gradual or sudden, which calls forth a corresponding change in the living protoplasm, is to be looked upon as a stimulus. The responses to stimuli, too, once thought of largely as those visible in curvature of motor organs or growing parts, are now conceived as of great variety. Invisible reactions probably outnumber the observable ones. Those producing a change of bodily form must be relatively few as compared with those which influence the performance of function or the course of development.

Diverse and numerous as are the stimuli which act upon plants, any conception of their operation would be faulty which fails to take into account the fact that stimuli of many unlike kinds and of unequal intensity are *interacting* to bring about the peculiar form and behavior of each individual plant. Think of the external agents which are known to be acting upon an ordinary land plant. About the aerial part the temperature varies from season to season, in our temperate zone changing from 30° below C. zero to 50° above; it varies from month to month and from day to day, even from hour to hour. The light differs in intensity and direction from day to night and from hour to hour. It changes in its actinic effect, as the photographer well knows, in the course of a few minutes; a variation, by the way, whose effect on plants has been entirely unstudied as yet. The moisture in the air is hardly the same for any two consecutive days; the plant is deluged with water for some hours or days and dry between rains; it is enveloped in fogs and mists; wet with dews at night, and all but blistered by the sun during the day. Its subterranean part is surrounded by solutions whose amounts and composition are probably varying hourly; whose concentration and consequent dissociation is changing from time to time. The temperature of the soil is scarcely the same from hour to hour; it varies between day and night, from day to day and from season to season. Imagine now the numberless combinations possible among these varying factors, and remember that all these interact as stimuli upon the protoplasm. What wonder, then, that no two plants are alike; that Capsella may flower at 5 cm. height with a few minute entire leaves, or may grow ten times higher with abundant foliage and long racemes of fruitful flowers!

This different conception of irritability and its relations to the functions of the

plant has led to many fruitful investigations during the past decade. The ingenious applications of plaster jackets for mechanical restraint of growth has thrown light not only upon the mechanical forces which can be exerted by growing organs, but casts a side light upon the difficult problem of the mechanics of growth. Researches upon the mechanics of curvature induced in growing organs by stimuli have been made by several observers, without obtaining, however, the concordant results which are to be desired. The subject, therefore, requires further study.

A satisfactory hypothesis as to what happens when an irritable organ is stimulated is still a desideratum. Is irritable protoplasm merely in a state of extraordinary lability, and does the stimulus initiate the decomposition of the protoplasm or of some unstable substance which it has produced? If this is true the metabolism of irritable organs which have been strongly stimulated ought to be different from that of similar but quiescent organs, and different products may be expected. One of the most noteworthy advances in this direction seems to be the discovery by Czapek (unfortunately we have had as yet only a preliminary paper) that roots after being geotropically stimulated contain notable amounts of reducing substances as compared with unstimulated roots which contain oxidizing substances instead.

Again, the transmission of impulses in plant tissues has been under frequent study. Haberlandt's seemingly well-founded conclusions regarding the transmission of impulses in Mimosa have proved untenable in the light of MacDougal's experiments, which also seem to shut out the possibility of the action of living protoplasm. The travelling of an impulse through a zone of dead cells is so marvellous that we are tempted to discredit the evidence of our senses, but that it occurs cannot be doubted. Thus, again, the discordant results of competent observers compel us to say that as good as nothing is now known.

ECOLOGY.

Within the past decade what may be considered a new division of plant physiology has been organized and has entered upon a development whose future extent and importance cannot yet be fully estimated.

Like every apparently new departure, it is an evolution from the old. Though its rise has been phenomenal, many of its facts and principles have long been known. At the meeting of the Madison Botanical Congress of 1893 the word *ecology* was almost new to American ears, and doubtless some present at that Congress were surprised at the introduction of a resolution on so unimportant a subject. The adoption of a name and preferable form of spelling for the new science, however, has been very useful in unifying the practice of American writers, and is a good illustration of the beneficial effect of a formal agreement on a matter of usage.

In the last century the relations of plants to insects were studied and Christian Conrad Sprengel's *Entdeckte Geheimniss der Natur* was a pioneer work in this subject. But Sprengel's work was destined to be forgotten for many years, and the further study of these interesting adaptations for the pollination of plants by insects was only revived by the prolonged observations and ingenious experiments of Charles Darwin. Since his time the work has been taken up vigorously and knowledge enormously extended by Müller, Ludwig, Delpino, McLeod, Robertson and a host of others.

The controlling influence of soil and climate upon the distribution of plants was also recognized and measurably understood long ago. In the classical works upon geographical distribution, such as Grise-

bach's *Vegetation der Erde* and Drude's *Pflanzengeographie*, the main features which form the basis for the grouping of plants are found to be those which constitute climate. Thus the moisture and heat relations of plants have dominated our thinking. The importance of these factors has particularly impressed itself upon students of local distribution. Again and again, in the past half century, local lists of plants have been compiled with little reference to the other conditions which determine the growth of plants. The limits of these local floras have been political boundaries, rather than the natural barriers to plant migration, or the physical features which determine climate. It has been the edge of the county, the boundary of the State, the limits of the country, which have been chiefly considered. In later years, however, the recognition of natural boundaries has become more common in these lists, and more attempts have been made to study the flora of a certain valley, a river system or a table land. Even so, however, natural barriers have been looked upon as controlling plant distribution merely through their effect upon climate, to the neglect of other factors.

In the last decade the increasing attention which has been given to the effect of external agents of all kinds upon plants, and the growing appreciation of the effect of stimuli upon plant form, acting through universal irritability, has led to the consideration of all the causes, small as well as great, which influence the well-being of plants. This knowledge, gradually accumulated, was first organized by Warming in his epoch-making work upon plant associations. Thus the subject of *ecology* was launched. The appearance of this great work not only brought into connection facts concerning the relations of plants to one another; it cast a new light upon the subject of plant geography. Facts and statistics which before had been dull and uninteresting to many, because without philosophy, now became luminous with new meaning.

This new light upon the geography of plants comes not merely from a consideration of the effect of the great factors of light, heat, moisture, and soil structure upon the plant; for these had been in a measure appreciated before. The new meaning arises from the introduction into the problem of the many minor factors of environment which act as stimuli and of the interminable variety of combinations which these present in their influence upon plant welfare. Among these environing conditions none is of greater importance than the effect of one plant upon another, partly direct and partly indirect, befriending some neighbors and injuring others. Because of these relations there arise groups of plants which grow well together, and others which are so antagonistic that they fly from one another's presence. These groundings may be due to causes the most remote or to relations the most intimate; according as they are due to one or the other will the association be closer or distant, the group large or small.

This phase of ecology, the study of plant societies, is yet in a somewhat chaotic condition. Not all the materials which are at hand have been satisfactorily organized, and much remains for future research. We await with impatience the settlement of various questions as to interpretation, and the acquisition of the multitude of new facts which are necessary before any true picture of the causes of form and the distribution of plant life is attainable.

It is a matter of some national pride that ecological investigations have been taken up vigorously by students in our own country, and that from the new standpoint some valuable researches on plant distribution have already been made. It is per-

haps also a matter of local pride that the most extensive study has been made in one of our great Western States, whose flora has been as yet comparatively little altered by the most potent of all disturbing factors, the hand of man. The *Phytogeography of Nebraska*, published a year or two ago by Pound and Clements, is the first extended study on plant geography in this country along distinctively ecological lines. The care and completeness with which their investigation was made render it a good example for future students of our flora, yet one which doubtless succeeding contributions will improve upon as the subject becomes better organized. As other examples of similar study may be mentioned the paper of Professor MacMillan upon the more restricted flora of the Lake of the Woods, and the only partially published work of Dr. Cowles upon the flora of the Lake Michigan dunes.

Plant names.—I venture to say that one of the most significant results of the study of ecology and physiological morphology is the growing dissatisfaction which its students feel with present methods of nomenclature, or perhaps I ought to say classification. I do not refer to the large grouping of plants into families, orders and divisions, but to the grouping of individual plants into species. This dissatisfaction is finding its expression among taxonomists as well. On the establishment of new species we are hearing almost daily the plea that it is better to separate into many species a group of nearly allied forms, although the differences used to distinguish them be very much slighter than those heretofore used for species. That is, it is better to do violence to our old idea of a species than to group together forms that in the field are easily recognized as unlike. This simply means that collectors and systematists are recognizing more fully the differences produced by unlike environment. It is a matter of common remark that the differences between individual plants recognized as belonging to one species are often greater than those which are used to separate species. Domesticated plants so easily pass into a variety of forms that for the sake of maintaining a rigid idea of specific rank cultivated plants have been quietly ignored. Now we are coming to see that in nature as in cultivation the plant is so plastic an organism that it is almost impossible to group together any individuals except those growing under identical conditions. What was devised as a convenience—namely, the establishment and naming of a species—is coming to be more and more of doubtful utility.

I will not undertake to say how much this species idea and nomenclature has retarded the true view of plant plasticity, but I feel sure that a good case might be made out for such a thesis. Whether any scheme can be devised which can replace the binomial nomenclature, whether any better method can be used by naturalists for designating the organisms which they are studying, is a matter for the future. I venture to prophesy, however, that the present system of nomenclature, by which I do not mean any particular kind of practice, whether of Paris, or Berlin, or Kew, or Cambridge, or Rochester, but the fundamental method of naming plants itself, *must go*. Our mere judgments, which we call species, foisted upon plants, do not conduce to a clear understanding of vegetable phenomena, but rather blind our eyes to a recognition of otherwise obvious truths. Some other method of identifying plants must be devised.

CYTOLOGY.

There is yet one other field whose development I must not fail to mention, though it does not pertain wholly to plant physiology. It goes without saying that the

functions of the plant body resolve themselves into the functions of the unit of that body. In every organ, however simple or however complex, we recognize the individual protoplast as the unit of work as well as the unit of structure. Each, enclosed in the armor-like wall which it has formed for itself, though hampered in its movements, is able to carry on the chemical and physical processes which constitute life without notable hindrance. Within the protoplast, for which Sachs uses the expressive though unnecessary word energid, there go on certain changes that can be observed with the microscope. These changes we look upon as the index of the invisible ones whose significance we seek to understand. It is natural, therefore, that the closest scrutiny should be made of the observable changes which take place within the cell. This minute study began in the attempt to ascertain how the living protoplasm constructed the wall with which it jackets itself. Every difference in composition which involved an optical alteration in the transmission of light, and so became visible, has been studied with the utmost care.

Later, attention was attracted to the division of the various independent protoplasmic organs within the cell body. Some of these have been found to be relatively simple. The division of the nucleus, however, has shown a complexity and at the same time a regularity which has challenged the minutest investigation and has made it the center of the greatest interest. So complex a series of changes, recurring with such regularity, argues an importance for both function and phylogeny which has made students eager to discover the secret. Therefore, within the last few years the behavior of the nucleus and of its different parts has been under study in all groups of plants with an exactitude never before dreamed of. Thus cytology has come to be an almost independent line of investigation. It is to be feared, however, that in many cases its exaltation has led students to mistake its real purpose and to consider it an end in itself. The visible processes within the cell will have little meaning unless they are looked upon as the mere index of its work. Unless the details of mitosis, for instance, are interpreted in the light of function or phylogeny they will certainly be misinterpreted or will be meaningless. It is becoming a question whether we have not overestimated the importance of slight differences in nuclear phenomena and whether further knowledge can be expected from a study of the visible processes within it. At the same time decided progress is to be hoped for in a more intimate chemical knowledge of the substances composing the nucleus, as to their chemical constitution and their relation to chemical reagents, such as stains and fixing fluids, rather than in repeated counting of chromosomes and multiplied observation of the details of prophase and anaphase.

I have now discussed the chief features of plant physiology in which notable progress has been making during the last decade. The great advances in plant chemics and physics; the progress in the investigation of causes of plant form; the widening ideas of the property of irritability; the investigation of the social relations of plants, and the minute study of cell action in spite of their diversity, have one great end in view. This is nothing less than the solution of the great problem—the fundamental problem—of plant physiology, as of animal physiology. The secret which we must discover, the dark recess toward which we must focus all the light that can be obtained from every source, is *the constitution of living matter.* Entrenched within the apparently impregnable fortress of molecular structure this secret

lies hid. The attacks upon it from the direction of physical chemistry and physiological morphology, of irritability, of ecology, and of cytology, are the concentrating attacks of various divisions of an army upon a citadel, some of whose outer defences have already been captured. The innumerable observations are devised along parallel lines of approach, and each division of the army is creeping closer and closer to the inner defences, which yet resist all attacks and hide the long-sought truth. We see yet no breach in the citadel. Here and there we seem to approach more closely and at certain points are getting glimpses, through this loophole or that, of inner truths, hidden before.

One outer circle of defences yet remains untaken, and until that falls it would seem that there is little hope of capturing the inner citadel. We *must* know more of the constitution of dead substances chemically related to the living ones. When the students of chemistry can put the physiologists into possession of the facts regarding dead proteids we shall renew the attacks more directly, with greater vigor and greater hope of success.

That ultimate success is to crown our efforts there is little reason to doubt. Ten years ago we little dreamed of the tremendous strides as since made toward the interpreting of life's central truth. The success of the past is the best augury for the future. The brilliant researches upon the chemistry of carbon compounds inspire us with renewed hope and put into our hands almost daily new weapons.

It is not possible to prove to-day that life and death are only a difference in the chemical and physical behavior of certain compounds. It is safe to say that the future is likely to justify such an assertion. In the meanwhile we press forward along the whole line. Botany is more than ever full of meaning, because with its sister sciences it is no longer seeking things, but the reasons for things.

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SECTION A—ASTRONOMY AND MATHEMATICS.

THE address of Vice-President Alexander Macfarlane entitled 'The Fundamental Principles of Algebra,' and the 'Report on Progress in Non-Euclidean Geometry,' by Professor George Bruce Halsted, of the University of Texas, are both to be published in full in SCIENCE and will not be treated further here.

A Report on the Recent Progress in the Theory of Linear Groups, presented by Professor L. E. Dickson, of the University of California, was of the nature of a supplement to the report on finite groups, read at the last annual meeting of the Association, by Dr. G. A. Miller, of Cornell. It is intended for publication in the *Bulletin of the American Mathematical Society*, in which the report of Dr. Miller appeared last year.

Part I. of the present report gives the general theorems relating to the canonical form of finite groups of linear substitution and to the generators of such groups. After a complete enumeration of the binary and ternary collineations in their historical setting, a number of special quaternary linear groups, particularly the famous one of order 51,840, are considered.

Part II. treats of linear groups in a Galois field, their order, generators, factors of composition and the isomorphisms existing between them. The Galois field is defined and a full bibliography added. The general linear homogeneous group, the linear fractional group, the Abelian linear group and its generalized form, the first and second hypoabelian groups, the orthogonal group, other linear groups with a quadratic invariant or a special invariant of degree q, the hyperorthogonal group and the hyperabelian group are all treated in turn. A number of

isomorphisms existing between these groups are tabulated. As many as six forms of a single group of order 25,920 are given, this group having applications in various geometric problems.

Professor Asaph Hall, Jr., of the University of Michigan, communicated to the Section certain results of a series of observations of the meridianal zenith of Polaris made by him between May, 1898, and July, 1899, with a view to determining the latitude variation at Ann Arbor and the aberration constant. The observations were made above and below the pole, both direct and reflected. The direct observations, at upper and lower culmination, respectively, give the values for the aberration constant $20''.60$ and $20''.58$, and for the parallax $0''.32$ and $0''.29$. The reflected observations show a close agreement with the direct observations. The observations are being continued.

A paper entitled 'Ancient Eclipses and Chronology' was presented by R. W. MacFarland, of Oxford, O. It is, in the main, a critical examination of the sources in ancient history from which the commonly accepted dates of various events are determined, and especially such sources as involve references to eclipses. The author of the paper reaches the conclusion that in each case examined the historical statement connecting a specified important event with an eclipse is either inadequate to establish accurately the relation of the two in time or else that the computations of the astronomers of the present day are not of sufficient accuracy to fix the eclipse in question within several years of the truth.

Professor H. C. Lord, of the Ohio State University, gave an interesting account of an investigation in which he has lately been engaged as to the best relative dimensions for different parts of a spectroscope which is to be used photographically, not visually. His account was fully illustrated by photographs and tables of results. He insisted especially upon certain advantages to be gained by using a camera of considerable focal length rather than one of short focus.

The proof of Grassmann's fundamental theorem, that there can be but two kinds of lineal multiplication of two factors, is somewhat long and rather difficult to follow. The object of the paper presented by Mr. Jos. V. Collins was to show how this proof may be shortened and simplified.

Professor G. J. Stokes, of Queen's College, Cork, Ireland, was prevented by sickness from finishing his paper on 'The Theory of Mathematical Inference.' The abstract of the incomplete paper indicates that the theory is advocated that the fundamental truths of mathematics are logical consequences of the mere fact or possibility of synthesis generally, and that ordinary mathematical inference is compounded of a logical or analytical element which has been reduced to mathematical form in Boole's Laws of Thought, and a synthetic element represented by Algebras of the type of Grassmann's *Ausdehnungslehre.*

A paper entitled 'Practical Astronomy during the First Half of the Present Century,' by Professor T. H. Safford, of Williamstown, Mass., unfortunately arrived too late to be read before the Section. It is a short and interesting account of the relations of the eminent astronomers Gauss, Bessel, the elder Struve and Airy to the astronomical progress made during the period stated.

Dr. G. A. Miller, of Cornell University, presented a short and interesting paper 'On the Commutators of a Group.' The following relations were brought out and commented upon by Dr. Miller: (1) If with a given group (G) commutators are formed with a fixed operator and all the operators of that group these commutators will generate a group which is transformed into itself by all the operators of the group G. (2) When the fixed operator transforms the

group G into itself the given commutators generate the smallest self-conjugate subgroup of G, which has the property that all the operators of the corresponding quotient group are commutative to the fixed operator. (3) If one of the elements of a commutator be multiplied on the left by each of the operators of a group it will be observed that the commutator remains unchanged when the multiplier is commutative to the other element, and that it is changed for every other multiplier. Hence this commutator has as many different values as the fixed element has conjugates when it is transformed by all the operators of the given group.

S. Kimura, of Japan, furnished a paper on 'Linear Vector Functions.'

One of the most interesting papers upon the program of Section A was 'The Determination of the Nature of Electricity and Magnetism,' by Professor R. A. Fessenden, of Western University, Allegheny, Pa. It was read before a joint session of Sections A and B, and will be reviewed in connection with the papers of Section B.

The fact that the American Mathematical Society was to hold a separate meeting at Columbus on Friday and Saturday of the Association week, and that the Conference of Astronomers and Astrophysicists is to be held at the Yerkes Observatory early in September, a date just late enough to make it inconvenient for persons who attended the Columbus meeting, both tended to reduce the length of program and the numnumber in attendance at Section A. It is to be hoped that the organizations in question may in the future see fit to cooperate with Section A. It seems obvious that many benefits must accrue to each of the three organizations from such cooperation, for they have many common members and common interests.

JOHN F. HAYFORD,
Secretary of Section A.

ELEVENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, COLUMBUS, OHIO, AUGUST 18 AND 19, 1899.

THE Association met in room 4, Biological Hall, Ohio State University, at 10 a. m., August 18. Fourteen members and a number of distinguished visitors were present, the average attendance at the four sessions being about twenty. The address of the retiring President, Mr. C. L. Marlatt, Washington, D. C., on 'The Laissez-faire Philosophy applied to the Insect Problem' was treated with an originality as courageous as refreshing. The author depicted the harmonious action of nature and called attention to her abundant powers of recuperation and self protection. The fundamental principles underlying the excessive multiplication and injury characterizing new or introduced species were explained,and an attempt was made to show the futility of efforts to prevent the introduction or secure the extermination of foreign insects once established in this country. These introductions of new forms are world movements not to be thwarted by man. The exploiting of short-lived or easily controllable ills was condemned and the unfair restrictions placed upon commerce by such efforts were pointed out. From the author's standpoint the only legitimate field for efforts in applied entomology is that of the local control of injurious species, and here the entomologist finds ample opportunity for the exercise of his powers in behalf of mankind. A general discussion of the address followed and while some of the members present were unable to accept entirely the conclusions of the author, all agreed that the address constituted a very important and valuable contribution to the philosophical literature of applied entomology.

Active members were elected as follows: C. S. Banks, Albany, N. Y.; Arthur Gibson, Ottawa, Canada; H. P. Gould, Col-

lege Park, Md.; S. J. Hunter, Lawrence, Kan. The foreign members elected were: Edward Barlow, Calcutta, India; E. E. Green, Pundaluoya, Ceylon; A. M. Lea, Hobart, Tasmania; J. S. O. Tepper, Adelaide, South Australia.

The list of papers read and discussed included the following: 'A Destructive Tanbark Beetle,' A. F. Burgess (read by the secretary); 'Voluntary Entomologic Service in New York State,' 'Notes of the Year for New York,' E. P. Felt; 'Recent Work against the Gypsy Moth,' 'The Destruction of Hairy Caterpillars by Birds,' E. H. Forbush; 'A Remedy for Gad-flies; Porchinski's Recent Discovery in Russia, with some American Observations,' 'The Establishment of *Blastophaga psenes* in California,' L. O. Howard; 'The Pea Louse, A New and Important Species of the Genus *Nectarophora*,' 'A New Method of Handling Hydrocyanic Acid Gas in Orchards,' 'Entomological Notes from Maryland,' 'The Stalk Worm, a New Enemy to Young Tobacco,' W. G. Johnson; 'An Improvement in the Manufacture of Arsenate of Lead,' 'A Probable Remedy for the Cranberry Fire-worm,' A. H. Kirkland; 'Miscellaneous Notes,' C. L. Marlatt; 'The Original Home of the San José Scale,' C. L. Marlatt and L. O. Howard; 'Observations on Insects of Sandusky and Vicinity,' H. Osborn; 'Insects of the Year in Georgia,' A. L. Quaintance; 'The Fatal Temperature for some Scale Insects in Georgia,' W. M. Scott; 'Insectary and Office Methods,' 'An Interesting Outbreak of the Chinch-bug in Northern Ohio,' F. M. Webster; 'Insects of the Year in Ohio,' F. M. Webster and C. W. Mally. The following papers were read by title: 'A New Breeding Cage for *Schizoneura lanigera*,' W. B. Alwood; 'A Destructive Orange Borer imported from Japan,' 'The Full Life History of *Pulvinaria acericola*, W. and R.,' L. O. Howard.

Officers for the ensuing year were elected as follows: President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary-Treasurer, A. H. Kirkland.

Resolutions were passed: (1) endorsing the work of the Massachusetts Gypsy Moth Committee; (2) the quarantine work of the California State Board of Horticulture; (3) expressing full sympathy with judicious State and National legislation tending to prevent the introduction of foreign insect pests and to secure the control or extermination of such as have become established in this country; (4) expressing appreciation of the action of the Honorable Secretary of Agriculture in publishing the proceedings of the Association in previous years; (5) expressing thanks to the local committee and the officers of the Association. The next meeting will be held on the two days preceding and at the same place as that of the American Association for the Advancement of Science.

A. H. Kirkland,
Secretary.

SCIENTIFIC BOOKS.

I Sogni, Studi psicologici e clinici di un alienista. Sante De Sanctis. Turin. 1899.

This latest of books about dreams and dreamers is written not only, as its title indicates, from the standpoint of the alienist, but also from that of the comparative psychologist. Its introductory chapters on literature and method are followed by discussions of the dreams of animals, children, old people and adults, of the dreams of the neuropathic, the mentally deranged and the delinquent.

It is safe to say that no book ever written on the subject has taken into account so large a number of dream experiences, for De Sanctis throughout compares the results of his own observation with the published records of the study of others. The book has thus a bibliography of three hundred and twenty-three numbers, though it dispenses with the convenience of page references.

The method of investigation which is most often employed is that of the statistical inquiry, but this is supplemented by the methods of personal questioning, observation of the sleeper's movements and experimental stimulation.

Practically all the methods by which dreams have been studied are therefore employed, except that of 'direct observation,' by which the dreamer, immediately after waking, records his own dreams and notes their vividness, their relation to waking experience and other important features. De Sanctis justly criticises this method, on the ground that the intention of studying one's dreams is itself an artificial condition, predisposing the subject to dreams of unusual frequency and of unnatural content; but the difficulty, which undoubtedly exists, he distinctly overstates, for individuals differ greatly in their ability to preserve a normal disposition under artificial conditions. The writer of this notice, for example, observed her own dreams, after the method already described, for nearly two months. The work of recording the dreams and their conditions was performed with mechanical, and, so far as possible, with unreflective, accuracy; and the study of the records was not undertaken until the completion of the observations. The result in this case was the record of about two hundred dreams, which were certainly very closely representative of the ordinary dream-life of the observer and noticeably destitute of unusual or abnormal features.

On the other hand, De Sanctis does not sufficiently emphasize the disadvantages of the statistical method which lies at the basis of the greater part of his conclusions. The extreme liability, varying as it does with individuals, to forget one's dreams, throws grave doubt upon the answers of people, untrained in introspection, to questions about the frequency and the vividness of dreams, the emotional nature and the connection with waking experience.

The uncertainty of the inference from bodily motions to the accompanying facts of consciousness, when these cannot be tested by the waking memory of the sleeper, seriously affects the conclusions of the chapter on the dreaming of animals. The discussion of children's dreams, on the other hand, is illuminating and suggestive in so far as it is based upon the author's personal study of the dream-life of his own children. He concludes that children begin to recall their dreams at four or five years of age and he identifies this period with the epoch of the distinct consciousness of self; but he concludes that children actually dream before the years when they recall their dreams, from the fact that characteristic movements in sleep, such as laughter and irregular breathing, which are later proved to accompany dreams, do actually occur before the fourth year.

Only twenty subjects of advanced age were questioned about their dreams, and these confirmed the ordinary statements concerning the infrequency and the colorlessness of the dreams of the aged. The fact that only one of these twenty reviews, in her dreams, the life of her youth, confirms the results of experimental studies in waking association, and shows that old people differ, like younger ones, in their tendencies to recall the distinct periods of their lives; some of them, waking and sleeping, occupy themselves mainly with the past, but others live a life full of present issues.

The chapter on the dreams of adults includes summaries of earlier work on the same line and the results of statistical inquiry comprising answers from one hundred and sixty-five men and from fifty-five women. These figures are too disproportionate in themselves to permit the comparison, which De Sanctis proceeds to make, between the dreams of men and of women. His conclusions, however, while numerically very different from those of Heerwagen, are of the same general nature; he finds (p. 135) that women's dreams are more frequent, more vivid and better remembered than those of men. Like all other investigators he shows also the close connection of dreams with waking experiences.

The discussion of the inquiry which follows—statistical and personal—into the dreams of the mentally deranged is itself too condensed to be readily summarized. Imbeciles and epileptics (except those slightly affected) are found to dream infrequently; hysteric patients, on the other hand, and paranoiac subjects are set down as constant dreamers.

The last of these comparative studies, that

of the dream-life of delinquents, is of especial interest. It is greatly to be regretted that De Sanctis fails to give more exact details of his method of inquiry. Written answers would have been impossible from most of these subjects, so it is probable that the statistics are compiled from personal questioning; and, in this case, it is reasonable to suppose that De Sanctis made his questions concrete enough to secure naïve and reliable answers. A fuller account of his methods should, however, have been given, especially in view of the unequivocal interest of the results (p. 237). Less than one-fourth of the one hundred and twenty-five criminal subjects, and only one-seventh of the class of lowest criminals, are frequent dreamers; whereas one-fourth of the entire number, and two-fifths of the most depraved, are never conscious of dreaming. This suggests, of course, a low degree of mental activity on the part of these subjects, and this indication is strengthened by the observation that by far the greater part of delinquents' dreams are of an entirely unemotional nature. The most curious effect of this tendency is that the criminal seldom dreams of his own crime and when he dreams of it is as likely as not to be entirely unmoved. Twenty-two subjects, out of ninety-three, acknowledged the occurrence of dreams of this character, but half of these stated that such dreams were without emotion.

The emotional nature of the dream is a subject which De Sanctis treats at length, to the comparative disadvantage of such topics as imagery, association and thought in dreams. The chapter on 'Sogni ed Emoziani,' which considers especially the relation of dream-emotions to those of the waking life, is one of the most suggestive of the entire volume. Its chief conclusions are these:

Nearly three-fifths of the normal adult subjects, and many of the hysterical and neurasthenic subjects, have dreams which are distinctly influenced by daytime emotional experiences. Chronic emotions, rather than unexpected and sudden feelings, and emotions of uncertainty, like doubt, suspicion, fear and hope, rather than feelings of settled grief, are reproduced in dreams. And, finally, De Sanctis records his conviction that only emotions of medium intensity are radiated out into the dream-life, since, as he observes, extreme feeling 'consumes force' by the organic excitement which accompanies it. For this reason, and also because suspense rather than certainty marks the dream-feeling, we so seldom dream of the dead at times of recent bereavement.

Cases in which the dream emotion is carried over into the waking life are carefully considered. De Sanctis is of opinion that many cases of the fixed idea and of paranoia are directly traceable to dream experiences, and the extent of his observations lends force to his remark that a suggestion, given for instance in the hypnogogic state, which should effect the dream-life, might indirectly influence the abnormal waking condition.

The experimental observations undertaken by De Sanctis were few in number and are insufficiently reported. The results, such as they are, confirm those of the few published records and of certain unreported experiments of the writer of this notice, all of them tending to show the possibility of artificial modification of the imagery and the emotion of a dream through artificial stimulation. The experimental study of dreams should, however, be widely extended, though the difficulty of accurately reporting the dream experience by the waking memory affects the most important factor of the experimental solution of psychic problems.

De Sanctis briefly summarizes and very justly estimates the physiological theories concerning sleep and dreams. He himself lays stress upon the comparative absence of peripheral stimuli, during periods of cerebral excitation, as at least a sufficient basis for the explanation of the dream experience.

MARY WHITON CALKINS.
WELLESLEY COLLEGE.

GENERAL.

THE International Institute of Bibliography at Brussels has published a pamphlet discussing the plans of the Royal Society's Catalogue of Scientific Literature. These are criticised somewhat severely, it being claimed that the Royal Society's plans are defective owing to lack of experience in bibliography and the failure to consider catalogues already in operation.

The pamphlet also contains a paper by Professor Ch. Richet on the physiological schedule, and reprints from this JOURNAL Dr. H. H. Field's article on the catalogue.

PROFESSOR ROWLAND'S table of solar spectrum wave-lengths originally printed in the *Astrophysical Journal* has been reprinted in a single volume containing 225 pages, and is offered for sale by the Press Division of the University of Chicago. The table gives the wave-lengths of nearly 20,000 lines measured from photographs made with the concave grating of the Johns Hopkins University.

BOOKS RECEIVED.

Descriptive General Chemistry. S. E. TILLMAN. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1899. Pp. x + 429.

Elementary Studies in Chemistry. JOSEPH TORREY, JR. New York, Henry Holt & Co. 1899. Pp. viii + 487.

Insects; Their Structure and Life: A Primer of Entomology. London, J. M. Dent & Co. Pp. xi + 494.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Naturalist* for August opens with an article by Vernon L. Kellog on 'The Hopkins Seaside Laboratory,' calculated to make Eastern naturalists envious of the advantages enjoyed by their friends on the Pacific coast. J. A. Allen discusses 'The North American Arboreal Squirrels,' in view of Mr. E. W. Nelson's recent revision of the Southern species of the group. William Trelease gives a brief biographical sketch of 'Alvin Wentworth Chapman,' and Thomas H. Montgomery, Jr., continues the 'Synopsis of North American Invertebrates,' with a short account of, and key to, the Gordiaceæ. An interesting account of 'An Abnormal Wave in Lake Erie' is given by Howard S. Reed. There is an unusually large number of reviews of zoological publications, and in the correspondence Dr. Alex Hrdlicka considers 'The Needs of American Anthropologists,' the greatest of which he believes to be the establishment of an Anthropological Institute to form a common, independent center.

The American Journal of Science for September contains the following articles:

Gas Thermometer at High Temperatures, by L. Holborn and A. L. Day.

Flicker Photometer, by O. N. Rood.

Quantitative Investigation of the Coherer, by A. Trowbridge.

Double Ammonium Phosphates of Beryllium, Zinc, and Cadmium in Analysis, by M. Austin.

Separation of Iron from Chromium, Zircomium and Beryllium by the Action of Gaseous Hydrochloric Acid on the Oxides, by F. S. Havens and A. F. Way.

Albertite-like Asphalt in the Choctaw Nation, Indian Territory, by J. A. Taff.

Notice of a New Meteorite from Murphy, Cherokee Co., N. C., by H. L. Ward.

Separation of Alumina from Molten Magmas, and the Formation of Corundum, by J. H. Pratt.

IT will be remembered that a department of agriculture for the British West Indian Islands was created last year with Dr. Morris, of Kew Gardens, as Director. We also called attention at the time to the agricultural conference held at Barbados in January. A further step in advance has now been taken by the establishment of a *West Indian Bulletin*, containing a number of articles on the agricultural problems of the islands. Like our agricultural bulletins, it is sent without charge to residents.

DISCUSSION AND CORRESPONDENCE.

DARK LIGHTNING.

TO THE EDITOR OF SCIENCE: I have been greatly interested by some photographs showing the rare phenomena of dark lightning, which have recently been sent to me. So far as I know, the only explanation that has ever been offered to account for them is photographic reversal, due to extreme brilliancy. This appears to me to be wholly out of the question for two reasons. In the first place, a dark line on the picture, resulting from over-exposure of a very brilliant line, would be surrounded by bright edges, due to the lesser photographic action in the halation region. This is never present, so far as I know, the dark flashes being minute dark lines ramifying from, or in the neighborhood of the main discharge. Secondly, from what evidence I can gather, the dark parts of the flash are not those which appear most brilliant to the observer. Mr. Jennings, of Philadelphia, who in 1890 secured a remarkable picture, reproduced in *Photographic Times Annual* for 1891, showing a very brilliant flash with

countless dark flashes covering the sky around it, tells me that the appearance to the eye was a brilliant white discharge, with fainter rose-colored ramifications, the latter developing in the negative, or rather positive, as dark flashes. Some years ago it occurred to me that a dark flash might be produced by a preponderance of infra-red radiations, which, as Abney has shown, undo the work of ordinary light on the plate. If we had a form of discharge capable of giving off very little actinic light, and an abundance of infra-red light, it might come out dark on a feebly illuminated background. This is, of course, a very wild guess, with nothing to substantiate it, but the dark flash appears to be a reality, and a poor hypothesis is perhaps better than none at all.

I have recently thought that the phenomenon might perhaps be explained in another way. We have a flash which appears darker than the sky behind it. It is inconceivable that the discharge could render the air in its path opaque in the ordinary sense to white light. But the light which illuminates the sky in the case of these pictures is not daylight, but light coming from another flash, that is made up of wave-lengths corresponding to the periods of vibration of the dissociated matter in the path of the discharge. Now, may it not be possible that in the dark flash we have a discharge, weak or nearly wanting in actinic light which, however, renders the air in its path capable of absorbing to some extent the radiations of the wave-lengths which come from the bright flash. Such a flash might possibly appear dark on a blackground feebly illuminated by light exclusively of these wave-lengths.

In other words, may we not have in the path of the dark flash, dissociated molecules, radiating but feebly, and capable of taking up vibrations of periods similar to their own, coming originally from a simultaneous brighter discharge?

It might not be impossible to reproduce the phenomenon by photographing a spark in front of a white background in an absolutely dark room. Sparks are almost always taken against a dark background, which would account for the absence of dark flashes in pictures of artificial discharges. A heavy main spark with lateral branches would seem the most suitable kind to employ.

The best method, however, of attacking the problem experimentally, it seems to me, would be a search for selective absorption in a partially exhausted tube. If the source of light were continuous any absorption would be unnoticeable unless it persisted for some time after the discharge (which is unlikely), for the time between successive discharges is very great in comparison to the actual duration of one of them. Even in the case of so-called continuous discharges produced by high potential storage batteries the discharge is often, and may always be, intermittent in character. The source of light should then be of no longer duration than the discharge occurring in the gas, the absorption of which is to be examined.

I can think of no way of producing a white or continuous spectrum source of as short duration as, and contemporaneous with, the discharge in the tube, but by employing two tubes differently excited, the one as a light source, the other as an absorption tube, some results might be obtained. Professor Trowbridge found that an argon tube emitted a blue light or red light, according to whether it was illuminated by means of an oscillatory or non-oscillatory discharge. By using the blue tube as the source and the red tube as the absorption tube, the two being arranged so as to be illuminated simultaneously, it might be found that the red tube had the power of absorbing to some extent the blue radiations from the other. I hardly think results would be obtained, but the experiment seems worth trying.

A picture taken by Mr. H. B. Lefroy, of Toronto, sent to me by Mr. Lumsden, Secretary of the Astronomical and Physical Society of Toronto, has some very curious appearances. There is an exceedingly brilliant flash running down the center of the plate, illuminating the sky quite brilliantly in its neighborhood. In its immediate vicinity, though not joined to it in any way, are innumerable dark, thread-like markings, which in places seem to cross each other, forming meshes.

Mr. Lumsden assures me that the testimony of all photographic experts who have seen the plate is to the effect that markings of that description could only be produced in the exposure; that is, they are not due to faults in the

film or the results of imperfect development. The fact that they are found only in the immediate vicinity of the bright flash is additional testimony in the same direction. These markings are wholly different from any that I have seen, not having the form of branched flashes. Something in their resemblance to photographs of sound-waves started by a spark, which I have recently made (see *Phil. Mag.* for August) suggested to me that they might possibly be due to the illumination of the sound-wave due to a powerful discharge by a second discharge. Under ordinary conditions, that is with a uniformly illuminated background, such waves would, of course, be invisible, but conditions might possibly arise, due to the proximity of black clouds, under which they might show—a sort of 'Schlieren Methode' on a large scale. I have not attempted yet to plan an arrangement of clouds, which, by acting as screens to light coming from certain directions, might render visible a region of the air, in which the optical density underwent a rapid change. In Mr. Lumsden's picture there are many dark clouds close to the flash. The idea of a photograph of a thunder-wave is a pleasing fancy at all events.

It seems to me that it will be impossible to formulate even a reasonable guess as to the cause of these dark flashes until a good many pictures are gotten together for comparison, and as much testimony as possible secured as to the appearance of the flashes to the eye. Personally, I have seen very few of the pictures and never the original negative.

My intention in writing this letter is not so much to advance theories accounting for the phenomenon of the dark-flash as to re-awaken an interest in the subject and bring out ideas from persons better qualified than I to treat the matter. R. W. WOOD.

MADISON, WIS.

A REPLY.

EDITOR OF SCIENCE: The review of my 'Elements of Practical Astronomy' by G. C. C., in SCIENCE for June 16th, criticises adversely some eight or ten small points. In so far as the article expresses the reviewer's individual opinions, there is no call for a reply, since that is the prerogative in which a critic should be protected. But I venture to say that the reviewer's zeal has led him unconsciously to make several erroneous statements.

In answer to the reviewer's remark: "Throughout his entire work the author appears to have ignored the advantage offered by addition and subtraction logarithms," I respectfully refer him to page 50, where both addition and subtraction logarithms are employed, and to the statement, p. 243: "If two quantities are given by their logarithms, and the logarithm of their sum or difference is required, it should be found by means of addition and subtraction logarithms." This covers the whole case.

The reviewer regrets that the book gives up '4% to diurnal parallax as affected by the earth's compression.' Such is not the case. Less than 2% is devoted to this subject, and in reality only about 1%, if we deduct the space demanded for the substitute treatment of the earth regarded as a sphere. Besides, the inclusion of this subject is imperative, unless, indeed, we exclude observations of meteors, the moon and any other near-at-hand bodies. Is G. C. C. willing to send out students of Practical Astronomy ignorant of the fact that there can be a parallax in azimuth? His criticism means just that.

The formula expressing the rate of a chronometer, p. 160, criticised in all seriousness by G. C. C., will meet his requirements if we replace the missing exponent 2 over the parenthesis—the only omission of the slightest consequence yet brought to my notice in the more than 400 equations. This formula is as fundamental in dealing with a chronometer as $\sin^2 + \cos^2 = 1$ is in Trigonometry, and should give a reviewer no trouble.

The reviewer refers to a well-known method of computing the azimuth, p. 199, and curiously enough misses the whole point of the method. He suggests another method—also well known—which in practical use is actually longer, with the added disadvantage of requiring two kinds of logarithms in the same solution. It is true that one solution by the first method requires 21 entries on the computation sheet (all the quantities being recorded), whereas the substitute

requires only 15 entries. But in this problem it is the custom to make several solutions in succession, in parallel columns; and in all columns after the first the criticised method requires fewer entries than does the suggested substitute. The reviewer's failure to see the point is all the more surprising, since, on the same page, alongside the first column, is a second column, in which only 10 entries are required. In fact, if no unnecessary recording is done, five entries are sufficient.

And most teachers of 'Practical Astronomy' will agree in my opinion that the wider publication of addition and subtraction logarithms has not done away with the desirability of 'adapting formulæ to logarithmic computation.' The solution of most problems is actually shortened by transforming the equations so that such logarithms are not needed. These logarithms were well known to Chauvenet, were referred to by him, and he made it clear (Vol. I., p. 211) when they should be used. In the class of problems we are considering, their wider publication has not influenced the form of solution appreciably with many astronomers, nor does it deserve to, for valid reasons. Take the case most strongly criticised by G. C. C.—that of determining the hour angle t from a measured altitude. I have—on five different pages—equally recommended using the well-known forms $\tan \frac{1}{2} t$ and $\sin \frac{1}{2} t$. I understand, and every reader of the criticism will understand, that G. C. C. would entirely replace these by the well-known form $\cos t$, not only in the example solved by me, but in all such solutions. A solution through $\tan \frac{1}{2} t$ requires 17 entries, but this method is the most accurate and most generally applicable of the three. Slightly less accurate and general is the solution through $\sin \frac{1}{2} t$, which requires 14 entries; and this is the form most frequently used by astronomers. The solution through $\cos t$ requires 13 entries, besides the use of two kinds of logarithms, and has the further disadvantage that it is less general than the other two forms. In fact, $\cos t$ should not be used at all if t is less than 30°; and the observer's position, combined with clouded skies, will often make observations under such conditions desirable. There are many astronomers, of the greatest experience, who would not use the $\cos t$ formula when t is less than 45°; they would employ the forms $\sin \frac{1}{2} t$ or $\tan \frac{1}{2} t$ in preference. To save one or two entries at the expense of accuracy and generality of the formulæ, strikes me as being poor astronomy and poor pedagogy.

It is plain that the reviewer regrets the insertion of an Appendix containing the principal 'Formulæ Resulting from the Method of Least Squares,' 'with no pretense at their derivation.' The Method of Least Squares is not a branch of Astronomy, any more than are Trigonometry and Logarithms. It is a method employed in all the sciences where quantitative observations are made. The formulæ used in applying the method have been appended for ready reference, and have been found convenient. There is no longer any practical reason for including a chapter on this subject, since several small text-books on Least Squares are available. There is one of some 60 pages written by a gentleman whose initials are G. C. C. (presumably the reviewer)—it is called a 'Treatise'—in which *the one fundamental equation of the subject is assumed*, 'with no pretense at its derivation.'

The reviewer objects to devoting $2\frac{1}{2}$ % "of the entire treatise to such an antiquated matter as lunar distances." As I explained in the book, this method "is occasionally of considerable importance to navigators and explorers." It is sufficient to say that the French *Connaissance des Temps* devotes about 5 % of its space, the British *Nautical Almanac* about 11 % and the American *Nautical Almanac* more than $13\frac{1}{2}$ % to the data for solving this problem.

Likewise, the objectionable $1\frac{1}{2}$ % devoted to the ring micrometer is introduced with the statement that results obtained with it "can be regarded as only approximately correct, and the ring micrometer should never be used with an equatorial telescope unless, in case of great haste, there is not time to attach the filar micrometer and adjust its wires by the diurnal motion;" and further "that it can be used with an instrument mounted in altitude and azimuth, * * whereas a filar micrometer cannot." These remarks cover the entire case, and it is impossible that they should mislead a student.

The reviewer has called attention to a real

error on p. 75, which I beg leave to acknowledge. By neglecting differential refraction in the determination of the value of a revolution of a micrometer screw (in the second of the three methods proposed) an error of about one part in 3,600 is introduced. That is, if the value of a revolution is 18″, the effect of neglected refraction is 0″ .005.

Again, by a slip of the pen, p. 43, the author is made to say that "*In all cases* the refraction must be applied first." There is one exception that, in altitudes measured from the sea horizon, the correction for dip should be applied previous to the correction for refraction.

My statement concerning the surveyor's transit, that the time, latitude and azimuth "can easily be determined to an accuracy within the least readings of the circle" is the literal truth, so far as the methods given by me are concerned. I have not attempted to get everything possible out of the surveyor's transit, and why should I? If great accuracy is required, instruments and methods specially adapted to the solution of the problem, and described in the earlier chapters of the book, will be employed. Why should an astronomer make a fad of a surveyor's transit when he has an observatory full of instruments which will do his work better? No further explanation is needed for the reviewer's remark that the surveyor's transit 'has been strangely neglected by astronomers.' W. W. CAMPBELL.

The reviewer, after careful consideration of Professor Campbell's remarks printed above, finds no reason to modify any of the opinions expressed in the review. G. C. C.

FOEHN WINDS.

TO THE EDITOR OF SCIENCE: In connection with Professor Wilson's communication on Foehn Winds in SCIENCE for August 18th, I beg to say that the word *foehn* was misspelled *foehm* in the proof sent me from the publication office of this JOURNAL. I made the necessary corrections in the proof, but for some reason the final *m* was left standing, instead of being replaced by the *n*. Being away from Cambridge at the time, I did not notice the mistake in the final printing of my note (in SCIENCE for July 21st) until a few days ago, and hence it happened that Professor Wilson anticipated me in making the necessary correction. R. DEC. WARD.

HARVARD UNIVERSITY, DEPARTMENT OF GEOLOGY AND GEOGRAPHY.

SCIENTIFIC NOTES AND NEWS.

THE University of Mississippi has conferred the degree of LL.D. on Dr. Eugene A. Smith, of the University of Alabama.

THE following appointments under the Department of Agriculture are announced: Mr. W. A. Orton, of the University of Vermont, Assistant in the Division of Vegetable Physiology and Pathology, and Mr. Hermann von Schrenk, Special Agent in this division: Messrs. C. R. Ball, E. D. Merrell and P. B. Kennedy Assistants in the Division of Agrostology.

DR. W. PFEFFER and Dr. Zirkel, professors of botany and of mineralogy, respectively, at Leipzig, have been elected foreign members of the Accademia dei Lincei, of Rome.

THE Académie Internationale de Géographie Botanique has conferred its international scientific medal upon Professor John M. Coulter, of the University of Chicago.

PROFESSOR G. H. HOWISON, of the department of philosophy of the University of California, and Professor Irving S. Stringham, of the department of mathematics, will spend the coming academic year abroad.

PROFESSOR A. C. ARMSTRONG, JR., who holds the chair of philosophy in Wesleyan University, will be abroad during the coming year.

PROFESSOR J. MARK BALDWIN has been given a half year's leave of absence from Princeton University to see the *Dictionary of Philosophy and Psychology* through the press in England. He intends to sail on September 19th and wishes all the American contributions, proofs, etc., to be in his hands in the first week of September. His London address is care Messrs. Macmillan & Co. His courses at Princeton will be in the hands of Professor H. C. Warren.

THE funeral of Sir Edward Frankland took place at Reigate on August 22, the services being conducted by the eminent geologist Professor Bonney. Among those present were Lord Lister, Sir Frederick Bramwell, Sir Henry

Roscoe, Sir Michael Foster, Dr. Ludwig Mond and Dr. Thorpe.

A Reuter dispatch from Liverpool states that, in consequence of the important discovery by Dr. Ronald Ross of the malarial mosquito, and the need of another man of science to be sent out immediately to Sierra Leone, the Liverpool School of Tropical Diseases has just selected Dr. Fielding Ould for this purpose. Dr. Fielding Ould, who has been much engaged in private research in connection with the Liverpool School of Pathology, has been specially trained by Professor Boyce, of the Liverpool University, in the study of tropical diseases. Dr. Fielding Ould had arranged to leave Liverpool for Sierra Leone by the Elder-Dempster steamer *Biafra* on Saturday, September 2.

We have already had occasion to state that the National Physical Laboratory, which will probably do for England what the Reichsanstalt does for Germany, was established through the efforts of the British Association for the Advancement of Science and is placed under the direction of the Royal Society. A further use of scientific societies is made by permitting six of the twelve elected members of the Council to be nominated by the great technical societies—the Institutions of Civil, Mechanical, Electrical and Naval Engineers, the Iron and Steel Institute and the Society of Chemical Industry. It is extremely important that our scientific societies should take action that will lead to the establishment of a national physical and chemical laboratory at Washington. A government which accomplishes so much for science as the United States should not neglect a field which Germany has shown to be so important to its industrial interests and on which Great Britain has now entered.

The British Medical Association will meet next year at Ipswich under the presidency of W. A. Elliston.

A commission has been appointed to enquire into the inland fisheries of Ireland. The scientific members are Dr. D. J. Cunningham, professor of anatomy in Trinity College, Dublin, and Dr. W. C. Macintosh, professor of natural history in the University of St. Andrews.

Professor W. E. Ritter, of the University of California, has returned from a biological expedition to Alaska, where he has been making collections for the University.

The Bavarian government has granted $1,500 to Dr. Karl Giesenhagen, for a tour through the unexplored interior of Malacca.

The Austrian explorer, Dr. H. Leder, who visited the ruins of Kara-Korum in 1892, is again in Central Asia, and writes that he has good prospects of reaching Lhasa, with the aid of the ruler of Urga. He intends to join one of the large caravans that go from Urga to the residence of the Dalai Lama.

Sir Edmund Antrobus, owner of Stonehenge, the famous monument on Salisbury Plain, England, has offered to sell it, together with 1,300 acres of adjacent land, to the British government, for £125,000.

In the prosecution of the general magnetic survey of the United States and countries under its jurisdiction by the Coast and Geodetic Survey, it will be necessary at times, and especially during the summer months, to employ temporarily and for short periods a number of men of the requisite scientific training. Persons are desired who have had experience in a university in physics or allied sciences; or persons who have taken post-graduate degrees in physics or allied sciences; or students who have had not less than two years' work in physics or allied sciences, including laboratory practice. There will be no educational examination for these positions, but applicants will be graded upon their training and experience, and will be required to file their applications with the Civil Service Commission prior to October 1, 1899, in order to have their names entered upon the register which will be prepared immediately after that date. The salaries for these positions will range from $30 to $75 a month, according to the character of the work and the qualifications of the applicant; and in exceptional cases, where the person employed has had repeated experience in magnetic work, the salary may reach $100 per month.

The Civil Service Commission also wishes to fill the position of electrical engineer in the Treasury Department at a salary of $1,400 per

annum. The examination will be held on September 17th, 18th and 19th.

LORD KELVIN writes to *Nature* from Aix-les-Bains under the date of August 7 as follows: "Last night, during a thunderstorm of rare severity in which brilliant flashes — single, double, triple or quadruple — followed one another at intervals often of not more than a few seconds of time, I was surprised to see, with great vividness, on a suddenly illuminated sky, two nearly vertical lines of darkness, each of the ordinary jagged appearance of a bright flash of lightning. I remembered to have seen two real flashes of just the same shapes and relative positions, and I concluded that the black flashes were due to their residual influence on the retina. I turned my eyes quickly from the dark sky outside to an illuminated wall inside the house, and I again saw the same double dark 'flash,' which verified my conclusion in an interesting manner. The fatigued part of the eye failed to perceive the brightness of the sky in the one case and of the wall in the other."

IN the course of an interview with Signor Marconi, a press representative obtained some information with reference to the arrangements for the wireless telegraphy demonstrations at the forthcoming meeting at Dover of the British Association. The headquarters of the British Association will be at the Town-hall, and it is here that the French and English scientific visitors are to have the opportunity of witnessing some wireless telegraphy experiments. Signor Marconi had just returned from the naval manœuvres, and planned to leave for America at the beginning of September. He would, however, superintend all the necessary arrangements for his demonstrations at the British Association. During the meeting these demonstrations will be left in charge of Professor Fleming, of University College, London. Messages of congratulation will probably be exchanged between Dover and different parts of Europe. Signor Marconi said that the trials between Dover Town-hall and the lighthouse at St. Margaret's had been a complete success, the tests applied yielding the most satisfactory results. Asked as to whether an attempt would be made to send messages direct between Dover Town-hall and Boulogne, Signor Marconi said this would depend upon circumstances. The installation at Wimereux, near Boulogne, is the property of the French government. It was possible to send direct communications, but certain alterations on the French side of the Channel would be necessary. As the French Association for the Advancement of Science would be holding its annual conference at Boulogne at the same time as the British Association at Dover, and as both societies would be cooperating together and exchanging courtesies, he thought there should be no difficulty in obtaining the necessary consent of the French government. Otherwise messages will be sent across the Channel between Dover and Boulogne *via* the South Foreland. Signor Marconi referred to the demonstrations with wireless telegraphy made during the recent naval manœuvres. The results of these demonstrations, he stated, had established the fact that, even with the present installation at the South Foreland lighthouse, messages could be exchanged with a fleet as far down the Channel as Cherbourg, a distance of about 100 miles, and even farther.

THE London *Times* states that several members of the expedition organized by Mr. Claude Beddington for scientific and geographical research in West Africa have returned to England. The route followed by the explorers lay through the *Hinterland* of the Gold Coast, the neutral zone (the delimitation of which is now the subject of diplomatic negotiation), and the *Hinterland* of the German colony, Togoland. Many districts hitherto unvisited by Europeans were traversed, and several new and interesting entomological specimens have been the result of the explorer's enterprise. The big game encountered included elephant, buffalo, hippopotamus and many rare species of antelope. Mr. Beddington was much struck with the enterprise shown by the German government in Togoland, where well-constructed roads and substantial government buildings, the result of large Imperial grants, form a striking contrast to the condition of things in the British territory. Among other industries encouraged by the German authorities is the planting of

kola trees, which should be a source of future wealth to the colony, as the kola nut seems to be almost an essential stimulant to every Hausa, and it is at present imported at great expense from Ashanti, where it is indigenous. The members of the expedition suffered from the usual malarial fever, but fortunately not to such an extent as to incapacitate them from much useful scientific work.

A RECENT issue of the *British Medical Journal* gives an abstract of the report of the Principal Chemist of the Government Laboratory for the year ending March 31, 1899, which has been issued as a Parliamentary paper. The number of samples of butter examined was 1,083, and only two were reported adulterated, as against 25 last year and 46 the year before. Experiments made at Wye and in the laboratory are held to have proved beyond doubt that the characteristic constituent of cotton-seed oil passes into the milk of cows fed upon cotton cake. Certain samples of butter examined during the year gave reactions for cotton-seed oil, but the amount indicated was held to be not more than might be due to feeding on cotton cake. The Danish and Scandinavian butters examined were entirely free from boric preservatives, but those from France, Holland, Australia and New Zealand contained such preservatives. The use of coloring matters derived from coal tar seems to be most prevalent in the United States, but is also met with in samples from Holland. The majority of the margarines contained cotton-seed oil, boric preservative and aniline coloring matters. Samples of cream imported from Holland, Denmark, Norway and Sweden were examined at the instance of the Local Government Board, and all found to be genuine. The laboratory also made a number of analyses in connection with the Home Office inquiries into the use of lead in pottery manufacture, and phosphorus in the manufacture of lucifer matches. Among the samples of food substances from various canteens examined for the War Department many proved to be of low quality. A number of medicinal preparations were examined for the Army Medical Department, and in several instances were found to be markedly inferior to the standards of the *British Pharmacopœia.*

UNIVERSITY AND EDUCATIONAL NEWS.

THE late Madame Halfon has bequeathed £1,600 to University College, London, for the foundation of two prizes.

A DINNER will be held at the end of November in aid of the fund to provide new laboratories for King's College, London. The Hon. A. J. Balfour will preside.

THE chair of botany at Yale University held by the late Daniel C. Eaton is hereafter to be known as the Eaton professorship of botany. The chair was endowed for Professor Eaton, but we believe not largely, and it is to be hoped that the corporation will appropriate the funds necessary to secure the services of a representative botanist.

PROFESSOR W. M. WHEELER, assistant professor of embryology in the University of Chicago, has been elected professor of zoology in the University of Texas. His address after September 15th will be Austin, Texas.

PROFESSOR J. L. KELLOGG, of Olivet College, Michigan, has been elected assistant professor of biology at Williams College, Williamstown, Mass.

ARTHUR ST. C. DUSTAN, associate professor of physics, University of Kansas, has been elected professor of physics and electrical engineering in the Alabama Polytechnic Institute, Auburn, Ala., in the place of Professor A. F. McKissick, who has resigned.

WALTER W. DAVIS, of the Psychological Laboratory of Yale University, has been appointed professor of physical culture and Director of the Gymnasium at Grinnell College, Iowa.

DR. RICHARD STOERNER, docent in chemistry in the University at Rostock, has been promoted to an assistant professorship.

THE following have qualified as docents in German universities: Dr. Behn, in physics in the University of Berlin; Dr. Neumann, in applied mathematics, and Dr. Grassmann, in mathematics in the University at Halle; Dr. V. Schmeidler, in physics, and Dr. Figdor, in plant anatomy and physiology, in the University of Vienna.

SCIENCE

FRIDAY, SEPTEMBER 15, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE FUNDAMENTAL PRINCIPLES OF ALGEBRA.**

THIS section of the Association, over which I have the honor of being called upon to preside, may be said to be a double section, for it comprises both mathematics and astronomy; as a consequence, the addresses which have been delivered by my predecessors fall into two distinct groups, the mathematical and the astronomical. Of the former class I have had the pleasure of listening to three: Professor Gibbs on Multiple Algebra, Professor Hyde on the Development of Algebra, and Professor Beman on a Chapter in the History of Mathematics. Each of these addresses was devoted to one feature or other of the development of Algebra, and the subject which I have chosen for to-day is another aspect of the same wonderful phenomenon. It is a subject which interests alike the mathematician and the philosopher, and indeed all thinking men, for it concerns the foundations of that science which is generally acknowledged to be the most perfect creation of the human intellect.

I propose then to review historically and critically the several advances which have been made respecting the fundamental principles of algebra. Here I am mindful of the advice which Horace gives a young

* Address by the Vice-President and Chairman of Section A., Astronomy and Mathematics, of the American Association for the Advancement of Science, Columbus meeting, August, 1899.

poet, not to begin his epic at the origin of things, but to hasten on to the event proper; consequently, I shall not go back to the Egyptians, Greeks, Hindoos, or Arabs, but at once proceed to the advances made in the present century.

One of the first results of the differential notation of Leibnitz was the recognition of the analogy between $\frac{d}{dx}$ the symbol of differentiation and the ordinary symbol of algebra; later the same analogy was perceived to hold for Δ_x the symbol of the calculus of finite differences. Guided by this analogy, Lagrange and other mathematicians of the French school, which flourished at the beginning of the century, inferred that theorems proved to be true for combinations of ordinary symbols of quantity might be applied to the differential calculus and the calculus of finite differences. In this way many theorems were enunciated, which appeared to be true, but of which it was thought to be almost impossible to obtain direct demonstration. Gradually, however, the view was reached that the logical connection amounted to more than analogy, and that the common theorems were true because the symbols in the three cases were subject to the same fundamental laws of combination. This advance was principally made by Servais, who enunciated the laws of commutation and distribution.

About the year 1812 a school of mathematicians arose at Cambridge which aimed at introducing the d-ism of the Continent in place of the dot-age of the University; in other words they believed in the practical superiority of the differential notation of Leibnitz over the fluxional notation of Newton. Their attention was naturally drawn to the questions which had sprung from the differential notation; and of the three founders of the school—Babbage, Herschel, Peacock—the last named took up the problem of placing the teaching of algebra more in consonance with the views which had been reached of the nature of symbols. Peacock considered algebra, as then taught, to be more of an art than a science; a collection of rules rather than a system of logically connected principles; and with the object of placing it on a more scientific basis, he made a distinction between arithmetical algebra and symbolical algebra. He treated these names as denoting distinct sciences, and he wrote an algebra in two volumes, of which one treats of arithmetical algebra and the other of symbolical algebra. He thus describes what he means by the former term: "In arithmetical algebra we consider symbols as representing numbers and the operations to which they are submitted as included in the same definitions as in common arithmetic; the signs $+$ and $-$ denote the operations of addition and subtraction in their ordinary meaning only, and those operations are considered as impossible in all cases where the symbols subjected to them possess values which would render them so in case they were replaced by digital numbers; thus in expressions such as $a + b$ we must suppose a and b to be quantities of the same kind; in others like $a - b$, we must suppose a greater than b and therefore homogeneous with it; in products and quotients, like $a\,b$ and $\frac{a}{b}$ we must suppose the multiplier and divisor to be abstract numbers; all results whatsoever, including negative quantities, which are not strictly deducible as legitimate conclusions from the definitions of the several operations must be rejected as impossible, or as foreign to the science."

Here it may be observed that Peacock is not true to his own principle; for $\frac{a}{b}$ is as impossible when b is not a divisor of a, as is $a - b$, when b is not less than a; in neither

case do we get a digital number. He draws the line so as to exclude the fraction as a multiplier but not as a multiplicand; according to his own principle it should be wholly excluded from arithmetical algebra. But arithmetic so restricted would be a very narrow science, and the logical result would be to divide arithmetic itself into an arithmetical arithmetic and a symbolical arithmetic.

He then describes what he means by 'symbolical algebra.' "Symbolical algebra adopts the rules of arithmetical algebra but removes altogether their restrictions; thus symbolical subtraction differs from the same operation in arithmetical algebra in being possible for all relations of value of the symbols or expressions employed. All the results of arithmetical algebra which are deduced by the application of its rules, and which are general in form, though particular in value, are results likewise of symbolical algebra, where they are general in value as well as in form; thus the product of a^m and a^n which is a^{m+n} when m and n are whole numbers, and therefore, general in form, though particular in value, will be their product likewise when m and n are general in value as well as in form; the series for $(a+b)^n$ determined by the principles of arithmetical algebra when n is any whole number, if it be exhibited in a general form, without reference to a final term, may be shown upon the same principle to be the equivalent series for $(a+b)^n$ when n is general both in form and value."

The principle here brought forward was named by Peacock the 'principle of the permanence of equivalent forms'; by means of it the transition is made from arithmetical algebra to symbolical, and at page 59 of 'Symbolical Algebra' it is thus enunciated: "Whatever algebraical forms are equivalent, when the symbols are general in form but specific in value, will be equivalent likewise when the symbols are general in value as well as in form."

One asks naturally, 'What are the limits set to the generality of the symbol?' Peacock's answer is, 'Whatsoever.' In the theory of reasoning the great question is not, 'How do we pass from generals to particulars?' but 'How do we pass from particulars to generals?' The application of general principles is plain enough—the difficulty is in explaining how we arrive at the truth of the general principles. The logician, seeking for light on this question, is apt to turn to exact science, and especially to algebra, the most perfect branch of exact science. Should he turn to Peacock, he finds that all that is offered him is this 'principle of the permanence of equivalent forms'; which, paraphrased, amounts to the following: We find certain theorems to be true when the symbol denotes integer number; let these theorems be true without restriction, and let us try to find the different interpretations which may be put on the symbol. Is not the following attitude more logical? We find certain theorems to be true, when the symbol denotes number; how far and no further may the conception of number be generalized, yet these theorems remain true without any alteration of form?; and, should the conception of number be still further generalized, what is the modified form which the theorems then assume? This is the logical process of generalization, whereas Peacock's process is "essentially arbitrary, though restricted with a specific view to its operations and their results admitting of such interpretations, as may make its applications most generally useful." (Report on Recent Progress in Analysis, p. 194.)

The two processes may be illustrated by their application to the binomial theorem, proved to be true for a positive integer index. According to Peacock's process,

$$(a+b)^n = a^n + na^{n-1}b + \frac{n(n-1)}{1.2}a^{n-2}b^2 +$$

is to be made a theorem in symbolical algebra, whether the series be finite or infinite, and all that remains is to find the different ways in which it may be interpreted. The process of generalization proceeds by steps. For instance, it asks: Will the series retain the same form when n is generalized so as to include any rational fraction? This is one of the questions which Newton proposed to himself, and settled in the affirmative; and it is recorded that he verified the truth of his conclusion by squaring the series for $(1-x^2)^{\frac{1}{2}}$. Peacock's principle does not distinguish divergent from convergent series; it is nothing but hypothesis, and any result suggested by it must stand the test of independent investigation.

An important advance in the philosophy of the fundamental principles of algebra was made by D. F. Gregory, a younger member of the Cambridge school of mathematicians. Descended from a Scottish family, already famous in the annals of science, he early gave promise of adding additional luster to the name; this he accomplished in a brief life of thirty-one years. In 1838 he read a paper before the Royal Society of Edinburgh 'On the Real Nature of Symbolical Algebra,' in which he says: "The light in which I would consider symbolical algebra is, that it is the science which treats of the combination of operations defined not by their nature, that is, by what they are or what they do, but by the laws of combination to which they are subject. And as many different kinds of operations may be included in a class defined in the manner I have mentioned, whatever can be proved of the class generally, is necessarily true of all the operations included under it. This, it may be remarked, does not arise from any analogy existing in the nature of the operations which may be totally dissimilar, but merely from the fact that they are all subject to the same laws of combination. It is true that these laws have been in many cases suggested (as Mr. Peacock has aptly termed it) by the laws of the known operations of number; but the step which is taken from arithmetical to symbolical algebra is, that leaving out of view the nature of the operations which the symbols we use represent, we suppose the existence of classes of unknown operations subject to the same laws. We are thus able to prove certain relations between the different classes of operations, which, when expressed between the symbols are called algebraical theorems. And if we can show that any operations in any science are subject to the same laws of combination as these classes, the theorems are true of these as included in the general case; provided always that the resulting combinations are all possible in the particular operation under consideration."

It will be observed that he places algebra on a formal basis; for its symbols are defined, not to represent real operations, but by laws of combination arbitrarily chosen. In a subsequent paper, however, entitled 'On a Difficulty in the Theory of Algebra,' he practically gave up the formal view, and appears inclined to adopt the realist view instead. He says: "In previous papers on the theory of algebra I have maintained the doctrine that a symbol is defined algebraically when its laws of combination are given; and that a symbol represents a given operation when the laws of combination of the latter are the same as those of the former. This, or a similar theory of the nature of algebra seems to be generally entertained by those who have turned their attention to the subject; but without in any degree leaning on it, we may say that symbols are actually subject to certain laws of combination, though we do not suppose them to be so defined; and that a symbol representing any operation must be subject to the same laws of combination as the

operation it represents." This is a departure from conventional definitions to rules founded upon the universal properties of that which is represented.

In the paper first quoted, Gregory considers five classes of operations. He supposes + and − to be defined by the rules of signs; and he finds in arithmetic a pair of operations which come under it, namely, addition and subtraction; and in geometry another pair, namely, turning through a circumference, and a semi-circumference respectively. But it is instructive to note that the difficulty referred to in the title of the later paper is none other than the view that + and − represent the operations of addition and subtraction; and he there shows that addition (including subtraction) is subject to a couple of very different laws, the commutative and the associative, though he does not use the latter term. It may be observed that the rule of signs applies to × and ÷ also; hence if + and − embraced addition and subtraction, so would × and ÷. The truth of the matter is that in ascending from arithmetic to algebra, we replace the coördinate ideas of *addition* and *subtraction* by the more general idea of *sum* and the subordinate functional idea of *opposite*. Similarly the coördinate ideas of multiplication and division are replaced by the more general idea of a *product* and the subordinate functional idea of *reciprocal*. The symbols − and ÷ then denote opposite and reciprocal respectively, while the ideas of sum and product are not expressed by symbols, but are sufficiently indicated by the manner of writing of the several elements. This difficulty appears to have upset his belief in the existence of classes of operations subject to the same laws of combination, yet totally dissimilar in nature, and without any real analogy binding them together.

According to Gregory, the second class of operations are index operations, subject to the two laws:

$$f_m(a)f_n(a) = f_{m+n}(a) \quad \text{and} \quad f_mf_n(a) = f_{mn}(a).$$

The third class comprises the ordinary symbol of algebra, and the symbols d and Δ of the calculus; they are subject to the distributive law

$$f(a) + f(b) = f(a + b),$$

and to the commutative law

$$f_1f(a) = ff_1(a).$$

The fourth class comprises the logarithmic operations subject to the law

$$f(a) + f(b) = f(ab).$$

The fifth class are the sine and cosine functions, subject to the laws expressed by the fundamental theorem of plane trigonometry, namely, the connection between the sine and cosine of the sum of two angles and the sines and cosines of the component angles.

Following as far as may be the chronological order, we come next to Augustus De Morgan, distinguished for his contributions alike to logic and to mathematics. In his 'Formal Logic' he takes a formal view of the nature of reasoning in general, and in his 'Trigonometry and Double Algebra' he lays down an excessively formal foundation for algebra. Indeed, it may be said that he carries formalism to its logical issue; and, thereby, he renders a service, for its inadequacy then becomes the better evident. In the chapter of the book mentioned, which is headed, 'On Symbolic Algebra,' he thus expresses the view he had arrived at: "In abandoning the meanings of symbols, we also abandon those of the words which describe them. Thus addition is to be, for the present, a sound void of sense. It is a mode of combination represented by +; when + receives its meaning, so also will the word addition. It is most important that the student should bear in mind that, *with one exception*, no word nor sign of arithmetic or algebra has one atom of meaning throughout this chapter, the object of which is symbols, and their laws of

combination, giving a symbolic algebra which may hereafter become the grammar of a hundred distinct significant algebras. If any one were to assert that + and − might mean reward and punishment and A, B, C, etc., might stand for virtues and vices, the reader might believe him, or contradict him, as he pleases, but not out of this chapter. The one exception above noted, which has some share of meaning, is the sign = placed between two symbols, as in $A = B$. It indicates that the two symbols have the same resulting meaning, by whatever steps attained. That A and B, if quantities, are the same amount of quantity, that if operations, they are of the same effect, etc." Let us apply to the theory quoted the logical maxim that the exception proves the rule, *prove* being used in the old sense of test. Well then, I say, because one symbol at least is found to be refractory to the theory, it follows that the theory is fallacious.

De Morgan proceeds to give an inventory of the fundamental symbols and laws of algebra, that for the symbols being 0, 1, +, −, ×, ÷, $(\ )^{(\ )}$ and letters. With respect to it the following questions may be asked: Why should $(\ )^{(\ )}$ be included, while the inverse idea, denoted by *log* is left out? What of the functional symbols *sin* and *cos*? Can they be derived from the above? As − denotes opposite and ÷ reciprocal, what are the signs for sum and product? Can they be derived from the above?

His inventory of the fundamental laws is expressed under fourteen heads, but some of them are merely definitions. The laws proper may be reduced to the following, which he admits are not all independent of one another:

I. Law of signs: $++=+$, $+-$ or $-+=-$, $--=+$,
$\times\times=\times$, $\times\div$ or $\div\times=\div$, $\div\div=\times$.

II. Commutative law: $a+b=b+a$, $ab=ba$.

III. Distributive law: $a(b+c)=ab+ac$.

IV. Index laws: $a^b \times a^c = a^{b+c}$, $(a^b)^c = a^{bc}$, $(ab)^c = a^c b^c$.

V. $a-a=0$, $a \div a = 1$.

These last may be called the rules of reduction. What Gregory gave was a classification of the more important operations occurring in algebra; De Morgan professes to give a complete inventory of the laws which the symbols of algebra must obey, for he says "Any system of symbols which obeys these rules and no others, except they be formed by combination of these rules, and which uses the preceding symbols and no others, except they be new symbols invented in abbreviation of combinations of these symbols, is symbolic algebra."

Compare this inventory with Gregory's classification. De Morgan brings × and ÷ under the same rule as + and −; he applies the commutative law to a sum as well as to a product; he introduces the third index law, which makes the index distributive over the factors of the base; he leaves out the logarithmic and trigonometrical principles and introduces what may be called the rules of reduction. From his point of view, none of them are rules; they are laws, that is, arbitrarily chosen relations to which the algebraic symbols must be subject. He does not mention the law pointed out by Gregory, afterwards called the law of association. It is an unfortunate thing for the formalist that a^b is not equal to b^a, for then his commutative law would have full scope; as it is, the index operations prove exceedingly refractory, so that in some of the beautifully formal systems they are left out of account altogether. Here already we have sufficient indication that to give an inventory of the laws which the symbols of algebra *must* obey, is as ambiguous a task as to give an inventory of the *a priori* furniture of the mind.

Like De Morgan, George Boole was a mathematician who investigated and wrote

in the field of logic. The character of the work done by the two men is very different. De Morgan's work bristles with new symbols; Boole uses only the familiar symbols of analysis. The former polished many small stones; the latter raised an edifice of grand proportions. The work done by Boole in applying mathematical analysis to logic necessarily led him to consider the general question of how reasoning is accomplished by means of symbols. The view which he adopted on this point is stated on page 68 of the 'Laws of Thought.'

"The conditions of valid reasoning by the aid of symbols are: *First*, that a fixed interpretation be assigned to the symbols employed in the expression of the data, and that the laws of the combination of these symbols be correctly determined from that interpretation; *Second*, that the formal processes of solution or demonstration be conducted throughout in obedience to all the laws determined as above, without regard to the question of the interpretability of the particular results obtained; *Third*, that the final result be interpretable in form, and that it be actually interpreted in accordance with that system of interpretation which has been employed in the expression of the data."

As regards these conditions it may be observed that they incline toward the realist view of analysis. True, he speaks of interpretation instead of meaning, but it is a fixed interpretation; and the rules for the processes of solution are not to be chosen arbitrarily, but are to be found out from the particular system of interpretation of the symbols. The thoroughgoing realist view is that a symbol stands for some definite notion in the subject analyzed, and that the rules of the analysis are founded upon universal properties of the subject analyzed. The realist view of mathematical science has commended itself to me ever since I made an exact analysis of relationship and devised a calculus which provides a notation for any relationship; can express in the form of an equation the relationship existing between any two persons, and provides rules by means of which a single equation may be transformed, or a number of equations combined so as to yield any relationship involved in their being true simultaneously. The notation is made to fit the subject, and the rules for manipulation are derived from universal physiological laws and the more arbitrary laws of marriage. The basis is real; yet the analysis has all the characteristics of a calculus, and throws light by comparison on several points in ordinary algebra. Its fundamental symbol expresses a relation; and what is the ultimate meaning of the algebraical symbol or of the symbol of the calculus but an operation or relation?

It is Boole's second condition which principally calls for study and examination; respecting it he observes as follows: "The principle in question may be considered as resting upon a general law of the mind, the knowledge of which is not given to us *a priori*, *i. e.*, antecedently to experience, but is derived, like the knowledge of the other laws of the mind, from the clear manifestation of the general principle in the particular instance. A single example of reasoning, in which symbols are employed in obedience to laws founded upon their interpretation, but without any sustained reference to that interpretation, the chain of demonstration conducting us through intermediate steps which are not interpretable to a final result which is interpretable, seems not only to establish the validity of the particular application, but to make known to us the general law manifested therein. No accumulation of instances can properly add weight to such evidence. It may furnish us with clearer conceptions of that common element of truth upon which the application of the principle depends, and so prepare the

way for its reception. It may, where the immediate force of the evidence is not felt, serve as verification, *a posteriori*, of the practical validity of the principle in question. But this does not affect the position affirmed, viz., that the general principle must be seen in the particular instance—seen to be general in application as well as true in the special example. The employment of the uninterpretable symbol $\sqrt{-1}$ in the intermediate processes of trigonometry furnishes an illustration of what has been said. I apprehend that there is no mode of explaining that application which does not covertly assume the very principle in question. But that principle, though not, as I conceive, warranted by formal reasoning based upon other grounds, seems to deserve a place among those axiomatic truths which constitute in some sense the foundation of general knowledge, and which may properly be regarded as expressions of the mind's own laws and constitution " (p. 68).

We are all familiar with the fact that algebraic reasoning may be conducted through intermediate equations without requiring a sustained reference to the meaning of these equations; but it is paradoxical to say that these equations can, in any case, have no meaning, no sense, no interpretation. It may not be necessary to consider their meaning; it may even be difficult to find their meaning, but that they have a meaning is a dictate of common sense. It is entirely paradoxical to say that, as a general process we can start from equations having a meaning and arrive at equations having a meaning by passing through equations which have no meaning. The particular instance in which Boole sees the truth of the paradoxical principle is the successful employment of the uninterpretable symbol $\sqrt{-1}$ in the intermediate processes of trigonometry. As soon, then, as the $\sqrt{-1}$ occurring in these processes is demonstrated, the evidence for the principle fails. As a matter of fact, the doctrine of algebraists about $\sqrt{-1}$ has long been a dark corner in exact science; and as a consequence it has been made the foundation for all sorts of crank theories. Recently I noticed that an ingenious individual had applied the $\sqrt{-1}$ and its successive powers to construct a mathematical theory of sensation. Before the introduction by Descartes of the geometrical idea of the opposite the use of $-$ in algebra might have been made the foundation for a similar transcendental theory of reasoning. Algebra, as the analysis of quantity in space, has a clear meaning for $\sqrt{-1}$ as the operation of turning through a right angle round a definite or an indefinite axis; in the former case it is vector in nature, because the axis must be specified; in the latter it is scalar in nature, because the axis may be any suitable one. It follows that $-$ denotes turning through two right angles, and this includes 'opposite' as a particular case. Thus an instance is still wanting on which to build the transcendental theory of reasoning enunciated by Boole.

The object of Boole's work, 'The Laws of Thought,'' is to investigate the fundamental laws of thought, to give expression to them in the symbolical language of a calculus, and upon that foundation to establish the science of logic. In the concluding chapter he considers the light which the inquiry throws on the nature and constitution of the human mind. Now, as a matter of fact, the subject analyzed is quality, and its connection with the nature and constitution of the human mind is nowise more inanimate than is the connection of algebra the science of quantity.

It is interesting to compare Boole's inventory of the symbols and laws for a calculus of reasoning (analysis of quality) with the inventory made by De Morgan for the symbols and laws of algebra (the analysis of quantity). The symbols are the same, ex-

cepting that $(\ )^{()}$ is omitted. The law of signs for + and − is the same, but none is given for × and ÷ on account of the ambiguity of the reciprocal; the commutative law applies to both sum and product; the distributive law applies to the product of sums; there are no index laws, excepting the peculiar one $a^2 = a$. The law of reduction $a - a = 0$ remains, but the complementary law $\frac{a}{a} = 1$ is not true in general.

How is the truth or suitability of these laws established? He says that it would be mere hypothesis to borrow the notation of the analysis of quantity, and to assume that in its new application the laws by which its use is governed would remain unchanged; to establish them he investigates the operations of the mind in reasoning as expressed by language, and applies Kant's theory of seeing the general truth in a particular instance. As regards the commutative law it may be remarked that Boole overlooks the fact that two notions may in their definition be coördinate with one another, or subordinate the one to the other, just as in the theory of probability there is a difference between two events which are independent of one another, and two events which are dependent the one on the other; and in the latter case it is not true that the order of the notions is indifferent. This is not the place to enter into a discussion of these so-called laws of thought; I wish merely to point out that Boole's view is essentially that of the realist; the fundamental rules of an analysis are not to be assumed arbitrarily, but must be found out by investigation of the subject analyzed.

Contemporaneously with Boole, and living on the same Emerald Isle, another mathematician spent many days reflecting on the fundamental principles of algebra—Sir W. R. Hamilton. His investigations started from the reading of some passages in Kant's 'Critique of the Pure Reason' which appeared to justify the expectation that it should be possible to construct *a priori* a science of time as well as a science of space. The principal passage is as follows: "Time and space are two sources of knowledge from which various *a priori* synthetical cognitions can be derived. Of this pure mathematics gives a splendid example in the case of our cognitions of space and its various relations. As they are both pure forms of sensuous intuition, they render synthetical propositions *a priori* possible." Thus, according to Kant, space and time are forms of the intellect; and Hamilton reasoned that, as geometry is the science of the former, so algebra must be the science of the latter. He amplifies that view as follows: "It early appeared to me that these ends might de attained by consenting to regard algebra as being no mere art, nor language, nor primarily a science of quantity, but rather as the science of order in progression. It was, however, a part of this conception that the progression here spoken of was understood to be continuous and unidimensional, extending indefinitely forward and backward, but not in any lateral direction. And although the successive states of such a progression might, no doubt, be represented by points upon a line, yet I thought that their simple successiveness was better conceived by comparing them with moments of time, divested, however, of all reference to cause and effect; so that the 'time' here considered might be said to be abstract, ideal or pure, like that 'space' which is the object of geometry. In this manner I was led to regard algebra as the science of pure time, and an essay containing my views respecting it as such was published in 1835." (Preface to 'Lectures on Quaternions,' p. 2.) If algebra is based on any unidimensional subject a difficulty arises in explaining the roots of a quadratic equation when they are imaginary. To get over the difficulty

Hamilton invented a theory of algebraic couplets, but the success of the invention is doubtful. In his presidential address before the British Association the late Professor Cayley said that he could not appreciate the manner in which Hamilton connected algebra with the notion of time, and still less could he appreciate the manner in which he connected his algebraical couplet with the notion of time. Whether Hamilton has effected the explanation or not, it appears to be logically possible, for a complex quantity can be represented by two segments of one and the same straight line.

But, be that as it may, Hamilton was led from algebraic couplets to algebraic triplets and to the problem of adapting triplets to the representation of lines in space. His guiding idea was to extend to space the mode of multiplication of lines in a plane already discovered by Argand, Warren and others; and it was here that he stepped from the time basis to the space basis—that is, passed from a unidimensional to a tridimensional subject, the latter including the former as a special case. To his surprise, he found that the multiplication of two lines in space, either one being expressed in terms of three elements, led to a product composed not of three, but of four elements; and this result he deemed so novel and characteristic that he selected it to give a name to the new method—'Quaternions.' As finally developed, the method rests on a geometrical basis; nevertheless it is the logical generalization of ordinary algebra, for the distinctive theorems of algebra, such as the exponential, binomial and multinomial theorems, have their generalized counterparts in quaternions. Since the time of Gauss, mathematicians have considered double or plane algebra to be the logical generalization of ordinary algebra; now quaternions bears to plane algebra the same logical relation which plane algebra bears to ordinary algebra. It is all algebra in the sense of being the analysis of quantity and the relations of quantities. Any one who admits De Moivre's theorem into algebra is logically bound to admit quaternions as the highest form of algebra. It is a common belief that quaternions has only a remote connection with algebra; that it is only one of several systems of noncommutative algebra, and that the mathematician can get on very well without it. But if the above is the true logical relation, then it must be the duty of every analyst to master its principles. It may be remarked here that the logical relation of quaternions to plane algebra is obscured by the prevalent but erroneous idea that the complex quantities of the form $x + iy$ represent vectors. They really represent, in their planar meaning, coaxial quaternions; that is, x is a scalar and the axis of y is the common perpendicular to the plane. Let, as usual, $w + ix + jy + kz$ denote a quaternion; the complex quantity is identical not with $w + ix$ or $ix + jy$, but with $w + kz$. The fallacy in question almost baffled Hamilton in his attempts at generalization, as may be seen from the account which he gives of the discovery in the *Philosophical Magazine* for 1844.

We shall obtain additional insight into the nature of the fundamental laws of algebra by considering the part which they played in the discovery of the quaternion generalization. In the endeavor to adapt the general conception of a triplet to the multiplication of lines in space Hamilton started out with the principles of commutation, distribution and reduction; but in order that the theorem about the moduli might remain true he soon felt obliged, not indeed to abandon the principle of commutation entirely, but to modify it so as to preserve the order of the factors while leaving the order of combination of the factors commutable. This principle, which had

previously been pointed out by Gregory as an independent principle, he called the law of association. As the principle of commutation was still assumed to apply to the terms of a sum, it followed that the principle of association also applied to them. Here, then, we have an important difference in the inventory of the laws of algebra. According to De Morgan algebra follows all the laws which he enumerated, and them only; but Hamilton showed that the legitimate extension of algebra to space requires the commutative law to be modified in the case of a product. And still further light is obtained on the nature of these laws by considering the way by which Hamilton satisfied himself of the truth of the principle of association. He sought for and obtained a geometrical proof, independent of the principle of distribution, and depending on theorems taken from spherical trigonometry or spherical conics. Thus a notable generalization of algebra was made, not by arbitrary choice of fundamental rules, nor by arbitrary extension of the rules for integer number, but by finding out the universal properties of the subject analyzed.

We have already found that the index operations form a valuable test of the soundness of any theory of algebra. If the method of quaternions is the true extension of algebra to space we expect it to throw new light on these operations. As a matter of fact, most of the works on quaternions ignore the subject or present instead the treatment for the plane. In Hamilton's 'Elements of Quaternions' there is a chapter headed 'On Powers and Logarithms of Diplanar Quaternions,' but what it contains is practically limited to the plane. Why? Because the author believed, and there states, that the fundamental exponential law is not true for diplanar quaternions; that is, for space

$$e^p \times e^q \text{ not } = e^{p+q}.$$

The source of error lies in regarding the sum of indices as commutative, for that amounts to holding that $e^p \times e^q = e^q \times e^p$, which is contrary to the principles of quaternions. Were $p+q$ a sum without any real order of the terms, then we might have an order of factors, that is, we might have

$$(p+q)(p+q) = p^2 + pq + qp + q^2 = p^2 + q^2 + 2\mathrm{S}pq.$$

But when the sum has a real order of p, prior to q, then we cannot at the same time, hold that one factor $p+q$ can be prior to another factor $p+q$; for in the expansion we should have the contradiction of p being prior to q and q at the same time prior to p. Hence when p is prior to q the second power is not formed in accordance with the distributive principle; it is $p^2 + 2pq + q^2$. When this is admitted the exponential principle stands, but the commutative principle for a sum of such indices goes, as does also the distributive manner of forming the power of such a sum.

As regards the third index law it is evident from the non-commutability of the factors in general that in space it ceases to be true. The rule of reduction for a sum of terms requires to be modified when the terms have a real order; for $p+q-q=p$, but $q+p-q$ is not equal to p. The term and its opposite must follow one another immediately in order that the reduction may be legitimate. Similarly, in the case of a product the factor and its reciprocal must follow one another immediately in order that the reduction may be legitimate. From these principles the generalization for space of all the fundamental theorems of algebra follows without difficulty, and the theory of logarithms and exponents becomes the most fruitful part of quaternion analysis.

We may now consider briefly how the advance made by Hamilton struck a contemporary mathematician—Professor Kel-

land, of the University of Edinburgh. It was his custom to teach the elements of quaternions to the students of his senior class, and I remember how all went well till he came to multiplication, where the part played by a vector as a multiplier was likened, in some mysterious manner, to the action of a corkscrew. In the introductory chapter of the 'Introduction to Quaternions' he remaks as follows on the process by which algebra is generalized: "It is only by standing loose for a time to logical accuracy that extensions in the abstract sciences—extensions at any rate which stretch from one science to another—are effected." And further on: "We trust, then, it begins to be seen that sciences are extended by the removal of barriers, of limitations, of conditions on which sometimes their very existence appears to depend. Fractional arithmetic was an impossibility so long as multiplication was regarded as abbreviated addition; the moment an extended idea was entertained, ever so illogically, that moment fractional arithmetic started into existence. Algebra, except as mere symbolized arithmetic, was an impossibility so long as the thought of subtraction was chained to the requirement of something adequate to subtract from. The moment Diophantus gave it a separate existence—boldly and logically as it happened—by exhibiting the law of *minus* in the forefront as the primary definition of his science, that moment algebra in its highest form became a possibility, and indeed the foundation stone was no sooner laid than a goodly building arose on it."

It seems to me that no greater paradox could be enunciated than to say that higher principles in exact science are reached by standing loose for a time to logical accuracy. How long a time does that which is illogical take to become logical? The true process is generalization, not illogical extension. No doubt, the generalized principle may at first be merely an hypothesis, and in that form it may be applied so that it may be verified by its results; but this is not standing loose to logical accuracy.

The same author gives the following account of how Hamilton *extended* algebra to space: "He had done a considerable amount of good work, obstructed as he was, when, about the year 1843, he perceived clearly the obstruction to his progress in the shape of an old law which, prior to that time, had appeared like a law of common sense. The law in question is known as the commutative law of multiplication. Presented in its simplest form it is nothing more than this: 'five times three is the same as three times five'; more generally it appears under the form of $ab = ba$ whatever a and b may represent. When it came distinctly to the mind of Hamilton that this law is not a necessity with the extended signification of multiplication he saw his way clear and gave up the law. The barrier being removed, he entered on the new science as a warrior enters a besieged city through a practicable breech." This account is, of course, inadequate, for Grassmann jumped over the same barrier in the shape of an 'old law,' yet he was unable to deal with angles in space. There is no occasion to speak disrespectfully of the law of commutation; it has its own place; Hamilton did not cast it aside as an obstruction; he modified it for a product of factors having a real order, and the modified form amounts to the law of association.

We shall now go back to another independent source of the development of the principles of algebra—Hermann Grassmann. Like his contemporary, Hamilton, he was remarkable alike for attainments in mathematics and philosophy, and, besides, he made important contributions to philology. No doubt specialists are necessary, but the investigation of the fundamental principles of a science requires one who is

more than a specialist, one who has not only studied a portion minutely, but has also taken a comprehensive glance over the whole. From the preface to the *Ausdehnungslehre* of 1844 we get an insight into the origin and development of his course of investigation, and we find that it was in a manner the reverse of Hamilton's. The former started from a variety of geometrical facts and developed a method which is independent of space, and has perhaps suffered from its *philosophische Allgemeinheit;* the latter started from general philosophical ideas and developed an algebra which is uniquely adapted to space of three dimensions. But, as their subjects were largely the same, their results, so far as they involve truth, must also be capable of unification to a large extent.

In the preface quoted, Grassmann informs us that he started from the treatment of negatives in geometry; he observed that the straight lines AB and BA were opposite, and that AB + BC = AC, whether the point C is beyond B or between A and B. This led him to the principle of geometrical addition—namely, that AB + BC = AC, whether A, B, C are in one straight line or not. It may be remarked here that this principle is all right so long as the components have no real order, such as forces applied at a point or the coördinates of a point; but that it does not apply where the components have a real order, as, for example, the sides of a polygon. In successive addition the straight line from the origin to the end of the polygon is the scalar result, but the area enclosed is another result, which depends on the form of the path.

Then turning to the product in geometry, he adopted the view that the parallelogram is the product of its two sides, whether these are at right angles or not. He next found that the geometrical ideas of a sum and a product which he had adopted satisfied the principle of distribution, but not the principle of commutation so far as the factors of a product were concerned. In the case of the products commutation could be made, provided the sign of the product were changed also—that is, they were subject to negative commutation. Another set of basal facts was taken from the doctrine of the center of gravity. He observed that the center of gravity may be considered as the sum of several points, the line joining two points as the product of the points, the triangle as the product of its three points, and the pyramid as the product of its four points; and from these facts he developed a method similar to the 'Barycentric Calculus,' of Möbius.

He also considered the geometrical meaning of the exponential function. He observed that if a denote a finite straight line and α an angle in a plane through the line, then ae^{α} denotes the line a turned through the angle α. The treatment of angles in one plane is easy, but on attempting to treat of angles in space he encountered difficulties which he was unable to surmount. This fact has been cited as indicating the superiority of Hamilton's method; while that is true, it must not be forgotten that Hamilton failed to generalize the exponential theorem.

What is the view which Grassmann takes of the fundamental principles of algebra? An answer to this question is found in the introduction to the *Ausdehnungslehre* of 1844. He divides the sciences into the real and the formal; the former treat of reality, and their truth consists in the agreement of thought with reality; the latter treat of thought only, and their truth consists in the agreement of the processes of thought with one another. Pure mathematics is the doctrine of forms. As a consequence he is obliged to place geometry under applied mathematics, for it has a real subject, and should anyone think otherwise he must deduce from pure thought the tridimen-

sional character of space. Were space a form of thought, so would be time and motion, and kinematics would also be a part of pure mathematics. So he relegates geometry to the real sciences, and he has a difficulty in retaining arithmetic even, for is it not based on axioms, whereas a formal science is based on conventions?

From the notion of the combination of terms he deduces that the placing of the brackets and the order of the terms may or may not be indifferent. There is a synthetic combination and an analytic combination; when the latter is unambiguous (that is, $a - a = 0$) then the placing of the brackets and the order of the terms is indifferent; synthetic combination is then called addition, and the analytic subtraction. Thus in Grassmann's view the commutative and associative laws are involved in the ideas of addition and subtraction. It may be observed that the old difficulty with subtraction is due to the fact that it is not thoroughly commutative, and that it is only to the generalized idea of composition that the commutative law applies. Besides, to define addition so as to exclude terms having a real order is an arbitrary restriction of algebra.

According to Grassmann's view multiplication is a combination of a higher order; that is, he assumes as the definition of multiplication the distributive principle in the two-fold form

$(a + b)\,c = ac + bc$ and $c\,(a + b) = ca + cb$.

It may be observed, however, that the true expression for the distributive principle is

$$(a + b)\ (c + d) = ac + ad + bc + bd,$$

which assumes that if there is any real order of the terms there can be only one real order $a\ b\ c\ d$.

As regards the laws of indices he says that involution is a combination of the the third order, and that for the sake of shortness he will omit all consideration of it. Besides, its formal definition would be of no use, for in the nature of things it can be applied only in the special sciences through real definitions. This failure to treat of the index laws tells against his whole theory of the nature of algebra. In fact, these laws are the touchstone whereby the soundness of any theory of the foundations of algebra may be tested.

In 1867 Hermann Hankel published his 'Theory of Complex Numbers.' The full title of the work is '*Theorie der complexen Zahlensysteme insbesondere der gemeinen imarginären Zahlen und der Hamilton'schen Quaternionen nebst ihrer geometrischen Darstellung.*' He had studied the writings of both Hamilton and Grassmann, and the aim of the book is to give a complete theory of the several systems, uniting them all under the notion of complex number. From the title we gather that he considered the algebraic imaginaries and the Hamiltonian quaternions as two distinct systems, formal in their nature, but having a representation in space. He begins with positive integer numbers, and finds from a consideration of the notion that the addition of such numbers satisfies the two laws of association and commutation, which he treats as independent of one another. But as regards the notion of the multiplication of such numbers he says that the truth of the commutative law or of the associative law is not self-evident; that the former law can be proved by a geometric construction in a plane, and the latter by a geometric construction in space. As regards the distributive law he says merely that it is a universal property of multiplication. As regards the base and index relation he says that neither the commutative law nor the associative law applies; he enunciates the same three index laws as De Morgan, but does not say whether they are self-evident or require a proof by geometric construction. Here, then, in a pro-

fessedly scientific work, some of these fundamental laws are treated as self-evident, others as requiring geometric proof, and others yet are merely enunciated. If in the case of multiplication the commutative law requires proof, so does it also in the case of addition, for it is just as self-evident that $2 \times 3 = 3 \times 2$ as that $2 + 3 = 3 + 2$.

The manner in which Hankel passes from arithmetic and arithmetical algebra to general algebra is as follows: Algebra, being formal mathematics, can be founded on any system of independent rules; but, in order that its results may be interpretable and that it may be capable of application, it is found convenient to choose the system of fundamental rules satisfied by common arithmetic; in other words, the laws of integer arithmetic are made the laws of algebra. This he calls the 'principle of the permanence of the formal laws,' and enunciates as follows (p. 11): "If two expressions stated in terms of the general symbols of arithmetical algebra (*arithmetica universalis*) are equal to one another they shall remain equal to one another when the symbols cease to denote simple magnitudes and the operations receive any other meaning." Peacock speaks of the permanence of equivalent forms; Hankel of the permanence of the formal laws. Peacock says, "Let any general equivalence in arithmetical algebra be true also in universal algebra"; Hankel says, "Let the fundamental laws of the former be made the fundamental laws of the latter." Hankel gives a more scientific form to what was meant by Peacock.

However, Hankel labors under a logical difficulty from which Peacock was exempt, for he does not take the laws of arithmetical algebra without exception; he rejects the commutative law for a product, in order that quaternions may be included among his complex numbers. But, it may be asked, why not reject the commutative law for addition also? So far as arithmetical algebra is concerned they stand on the same basis. If, as has been shown, the sum of quaternion indices is not commutative we are logically bound, on his principles, to reject the commutative rule for addition also. We are reduced to the alternative: the choice of the fundamental rules is arbitrary, or else they must be founded on the properties of the subject analyzed. The permanence of the formal laws is nothing but hypothesis, and in the case of any generalization must be tested by real investigation.

One of the clearest thinkers on mathematical subjects in recent times was Professor Clifford, who like several of the mathematical philosophers we have spoken of, was cut down in the midst of his scientific activity. In his posthumous work entitled 'The Common Sense of the Exact Sciences' there are chapters on number and quantity in which he explains his views of the fundamental principles of algebra. He starts out from the principle, which he attributes to Cayley and Sylvester, that the number of any set of things is the same in whatever order we count them, and deduces from it, by means of diagrams, the commutative and associative rules for positive integer number. He says that they amount to the following: "If we can interchange any two consecutive things without altering the result then we may make any change whatever in the order without altering the result." It may be remarked that this shows that the commutative and associative properties are not independent, but that the former involves the latter. He next shows, by a diagram, that the distributive rule is true for the two forms $a(b + c) = ab + ac$ and $(b + c)a = ba + ca$, but he does not consider the complete form of the rule $(a + b)(c + d) = ac + ad + bc + bd$.

As regards the impossible subtraction and division he says (p. 33): "Every operation in mathematics that we can invent

amounts to asking a question, and this question may or may not have an answer according to circumstances. If we write down the symbols for the answer to the question in any of those cases where there is no answer, and then speak of them as if they meant something, we shall talk nonsense. But this nonsense is not to be thrown away as useless rubbish. We have learned by very long and varied experience that nothing is more valuable than the nonsense which we get in this way; only it is to be recognized as nonsense, and by means of that recognition made into sense. We turn the nonsense into sense by giving a new meaning to the words or symbols which shall enable the question to have an answer that previously had no answer."

This is the true phenomenon in algebra; it is more logical than its framer. How can it be possible, unless the algebraist founds his analysis upon real relations? It is the logic of real relations which may outrun the imperfect definitions and principles of the analyst and make it necessary for him to return to revise them.

To get over the impossible subtraction he introduces instead of the discrete unit supposed by number, the idea of a step, making plus mean 'forwards' and minus 'backward.' The summing of steps is independent of the order in which they are taken, and a minus step is just as independent as a plus step. When these symbols occur in multipliers he gives them, not the meaning of 'forwards' and 'backwards,' but that of 'keep' and 'reverse.' He gives them these meanings in addition to their former meanings, and leaves it to the context to show which is the right meaning in any particular case. It may be remarked that it is doubtful whether in any case two distinct meanings can be given to a symbol at one and the same time without producing confusion. It seems to me, as already stated, that the most general meanings of + and − are the angular ideas of an even and an odd number of semi-circumferences, but this reduces in certain cases to the linear ideas of direct and opposite.

From the idea of step he passes to the idea of operation, on the theory that a product may be composed either of a step and an operation or of two operations. As a matter of fact, an operation is merely a relationship which may subsist between two quantities; and we may have two distinct products, one expressing a related quantity, the other a compound relationship. The analysis of operations is a special part of the more general analysis of relationships. According to Clifford's view, because a sum of operations of the kind considered is independent of the order of the operations, it follows that

$$a + b = b + a \qquad ab = ba$$
$$a(b + c) = ab + ac \qquad (a + b)c = ac + bc.$$

As regards the advance from numbers to quantity he says ('Philosophy of the Pure Sciences,' p. 240): "For reasons too long to give here, I do not believe that the provisional use of unmeaning arithmetical symbols can ever lead to the science of quantity; and I feel sure that the attempt to found it on such abstractions obscures its true physical nature. The science of number is founded on the hypothesis of the distinctness of things; the science of quantity is founded on the totally different hypothesis of continuity. Nevertheless, the relations between the two sciences are very close and extensive. The scale of numbers is used, as we shall see, in forming the mental apparatus of the scale of quantities, and the fundamental conception of equality of ratios is so defined that it can be reasoned about in terms of arithmetic. The operations of addition and subtraction of quantities are closely analogous to the operations of the same name performed on numbers, and follow the same laws. The composi-

tion of ratios includes numerical multiplication as a particular case, and combines in the same way with addition and subtraction. So close and far-reaching is this analogy that the processes and results of the two sciences are expressed in the same language, verbal and symbolical, while no confusion is produced by this ambiguity of meaning, except in the minds of those who try to make familiarity with language do duty for knowledge of things."

What is the analogy here spoken of? It cannot be a mere rhetorical analogy; it is a true logical analogy. But what is a logical analogy, except that the subjects have something in common, which is the basis of the common properties. The logical relation of number to quantity is that of subordination; we cannot pass deductively from the former to the latter, but we can pass deductively from the latter to the former. It is easy to pass downwards from quantity to number; the difficulty is in passing upwards from number to quantity.

The most elaborate treatise on algebra written in the English language within recent times is Chrystal's 'Text-book of Algebra,' published in two volumes. The task which the author sets before himself is the same as that which Peacock undertook —namely, to place the teaching of the elements of algebra on a scientific basis, and abreast of what may be called the technical knowledge of the day. In the first volume he starts out with the idea of building up the science on the three laws of association, commutation and distribution, the two former being applicable to addition and subtraction, multiplication and division, and the third to multiplication. The view which he takes of these laws is expressed by the phrase 'canons of the science,' as is evidenced by the following passage: "As we have now completed the establishment of the fundamental laws of ordinary algebra, it may be well to insist once more upon the exact position which they hold in the science. To speak, as is sometimes done, of the proof of these laws in all their generality is an abuse of terms. They are simply laid down as the canons of the science. The best evidence that this is their real position is the fact that algebras are in use whose fundamental laws differ from those of algebra. In the algebra of quaternions, for example, the law of commutation for multiplication and division does not hold generally."

If it is an abuse of terms to speak of the proof of these laws why does Hamilton devote page upon page to the proof of the associative law for a product of quaternions? He is not content with laying it down as a canon; he investigates whether it corresponds to nature. No doubt, the function of the expositor is different from that of the investigator; the latter must establish principles in the best way he can; the former may proceed deductively from these principles as the axioms of the science. But the idea of 'canon' involves something arbitrary and formal which is not involved in the idea of an 'axiom.'

But if we turn to the second volume we find evidence against the canonical nature of these laws, for the author admits that they must be modified within the bounds of algebra itself. The law of association cannot be applied to the terms of an infinite series, unless it is convergent; the law of commutation cannot be applied to the terms of an infinite series, unless it is absolutely convergent; and the law of distribution requires modification when applied to the product of two infinite series. If, in any case, the so-called canons are modified there must be some higher authority to which appeal is made. The only conclusion left is that the rules in question are not canons at all, excepting in so far as they represent properties of the subject analyzed.

I may here refer to the prevalent doctrine

that the number-system of arithmetic closes with the complex number, and that the operations of algebra give no indication of any higher imaginary form. For instance, in an article on 'Monism in Arithmetic,' Professor Schubert says: "In the numerical combination $a + ib$, which we also call number, we have found the most general numerical form to which the laws of arithmetic can lead, even though we wished to extend the limits of arithmetic still further. * * * With respect to quaternions which many might be disposed to regard as new numbers it will be evident that though quaternions are valuable means of investigation in geomtry and mechanics they are not numbers of arithmetic, because the rules of arithmetic are not unconditionally applicable to them." When the plane of the complex quantity is that of the axes of x and y it is true that no higher form appears, because in multiplication we get only k and k^2, which is -1. But when Hamilton took for the common plane a general plane passing through the axis of x he immediately encountered a higher form jk, and the problem resolved itself into finding the meaning of that new imaginary combination. He had a great difficulty in emerging out of 'Flatland,' but he succeeded in doing it. The reason given for excluding the quaternion cannot apply, for it would exclude infinite series, as the rules of arithmetic are not unconditionally applicable to them.

Last year there appeared the first volume of a 'Treatise on Universal Algebra,' by Mr. Whitehead, of Trinity College, Cambridge. By universal algebra the author means the various systems of symbolic reasoning allied to ordinary algebra, the chief examples being Hamilton's Quaternions, Grassmann's Calculus of Extension and Boole's Symbolic Logic. The author does not include ordinary algebra in his treatment, and the main idea of the work is not unification of the methods, nor generalization of algebra so as to include them, but a detailed study of each structure, to be followed by a comparative anatomy. In this idea of comparative anatomy there is involved the assumption that these methods are essentially distinct and independent. But that they overlap to a large extent is very evident.

The author preaches the view of the extreme formalist; nevertheless, at various places he makes admissions which are very damaging to it. As regards the fundamental rules he says: "The justification of the rules of inference in any branch of mathematics is not properly part of mathematics; it is the business of experience or philosophy. The business of mathematics is simply to follow the rules. In this sense all mathematical reasoning is necessary; namely, it has followed the rule." Must the mathematician wait for the experimenter or the philosopher to justify the rules of algebra? Was it no part of Hamilton's business to test whether the associative law is true of a product of spherical quaternions? To advance the principles of analysis is surely the special work of the mathematician; to follow the rules discovered is work of a lower order.

Mr. Whitehead thus describes a calculus: "In order that reasoning may be conducted by means of substitutive signs it is necessary that rules be given for the manipulation of the signs. The rules should be such that the final state of the signs after a series of operations according to rule denotes, when the signs are interpreted in terms of the things for which they are substituted, a proposition true for the things represented by the signs. The art of manipulation of substitutive signs according to fixed rules, and of the deduction therefrom of true propositions, is a calculus." By substitutive sign is meant one such that in thought it takes the place of that for which it is sub-

stituted. He quotes with approval a saying of Stout's that a word is an instrument for thinking about the meaning which it expresses, whereas a substitutive sign is a means of not thinking about the meaning which it symbolizes ; and he adds that the use of substitutive signs in reasoning is to economize thought.

It seems to me that a sign economizes thought in precisely the same way that a word economizes thought, but to greater degree. A word is introduced to dispense with a long phrase or description, and in using the word one no more thinks of its meaning than in using an algebraic symbol does one think of the particular meaning it is made to stand for, for the time being. There seems to be a lurking fallacy that thought is economized by dispensing with it altogether. I prefer the saying of Clifford, with reference to $(a+b)^2 = a^2 + 2ab + b^2$ and its expression in English: "Two things may be observed on this comparison —first, how very much the shorthand expression gains in clearness from its brevity; secondly, that it is only shorthand for something which is just straightforward common sense and nothing else. We may always depend upon it that algebra which cannot be translated into good English and sound common sense is bad algebra."

In his statement of the fundamental principles of algebra Whitehead follows Grassmann to a large extent. He divides them into two classes, the general and the special; the former apply to the whole of ordinary and universal algebra; the latter apply to special branches only. The general principles are as follows: Addition follows the commutative and associative laws; multiplication follows the distributive law, but does not necessarily follow the commutative and associative laws. The theory looks beautiful and plausible, but it does not stand the test of comparison with actual analysis, for quaternions is one of the principal branches of universal algebra, and in it the addition of indices is in general non-commutative, and the power of a binomial of indices is not formed after the distributive law.

But in addition to this formal bond we find in the book another bond uniting the several parts into one whole. In the preface Mr. Whitehead says: "The idea of a generalized conception of space has been made prominent in the belief that the properties and operations involved in it can be made to form a uniform method of interpretation of the various algebras. Thus it is hoped in this work to exhibit the algebras, both as systems of symbolism and also as engines for the investigation of the possibilities of thought and reasoning connected with the abstract general idea of space." The chance for any arbitrary system of symbolism applying to anything real is very small, as the author admits; for he says that the entities created by conventional definitions must have properties which bear some affinity to the properties of existing things. Unless the affinity or correspondence is perfect, how can the one apply to the other? How can this perfect correspondence be secured, except by the conventions being real definitions, the equations true propositions and the rules expressions of universal properties? The placing of the algebra of logic on a space basis has been criticised, but in reply it may be pointed out that logicians have been accustomed ever since the time of Euler to prove their principal theorems by means of diagrams.

Our conclusion about the fundamental rules of algebra is: If the elements of a sum or of a product are independent of order, then the written order of the terms is indifferent, and the product of two such sums is the sum of the partial products; but when the elements of a sum or of a product have a real order, then the written

order of the elements must be preserved though the manner of their association may be indifferent, and a power of a binomial is then different from a product. This applies whether the sum or product occurs simply or as the index of a base.

Descartes wedded algebra to geometry; formalism tends to divorce them. The progress of mathematics within the century has been from formalism towards realism; and in the coming century, it may be predicted, symbolism will more and more give place to notation, conventions to principles and loose extensions to rigorous generalizations.

Alexander Macfarlane.
Lehigh University.

PROCEEDINGS OF THE BOTANICAL CLUB OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT COLUMBUS, AUGUST 21–24, 1899.

The Botanical Club met in the room assigned for the meetings of Section G pursuant to the resolution adopted by the Boston meeting, Tuesday morning at 9 o'clock, Dr. Byron D. Halsted presiding. The sessions were continued at that hour each morning, and completed by a meeting at 1:30 p. m., Thursday. In the absence of the Secretary, A. D. Selby was chosen Secretary *pro tempore*.

The attendance and interest in the proceedings of the Club were very satisfactory. The number of papers read was quite equal to the time secured for them.

Under the title 'A Greasewood Compass Plant,' Dr. C. E. Bessey reported that on the high, western Nebraska foot-hills a shrubby species of *Sarcobatus* was observed to bear its leaves in an upright position, with their blades parallel to the meridian. Specimens were obtained for microscopic examination.

The same author gave an account of 'A Visit to the Original Station of the Rydberg Cottonwood.' "This species (*Populus acuminata* Ryd.) was discovered a few years ago in Roubedean Township, in Scott's Bluff County, in western Nebraska, in Carter Cañon. This is a broad cañon bounded by high pine-covered buttes, and in the bottom of the broad cañon is a narrower one fringed with deciduous trees—box elder, elm, cottonwood, willow, plum, red cedar, etc., and among them are clumps of the Rydberg cottonwood. The trees are symmetrical and of much greater beauty than those of the common cottonwood. When old the bark of the trunk is light-colored and very deeply fissured.

Dr. N. L. Britton reported to the Club that Mr. and Mrs. A. A. Heller, who were sent to Porto Rico last winter as collectors for the New York Botanical Garden, had returned, having secured about 1,400 numbers, representing probably over 1,200 species, and over 6,000 specimens of plants. They are now being studied.

Dr. William Saunders gave a brief account of 'The Arboretum and Botanic Garden of the Central Experimental Farm at Ottawa, Canada, established in 1889.' During that year 200 species and varieties of woody plants were planted in botanical groups. Additions were made from year to year, and by the end of 1894 the collection included about 600 different species and varieties. Since 1894 progress has been much more rapid, and up to the present time the total number of species under test or which have been tested is 3,071—of these 1,465 have been found hardy, 320 half hardy, 229 tender, 307 winter-killed and 740 have not been tested long enough to admit of an opinion on their hardiness. Where specimens pass the winter uninjured, or with very small injury to the tips of the branches only, they are classed as hardy. When killed back one-fourth to one-half, half-hardy; when killed to the snow-line, tender. A considerable collec-

tion of hardy herbaceous plants has also been brought together, consisting of about 1,100 species and varieties.

'Tomato Fruit-Rot' was discussed by Professor F. S. Earle, Auburn, Alabama. This disease occurs in all parts of the country where the tomato is grown. It has been attributed to a fungus, *Macrosporium Tomato*. Jones and Grout have shown that this fungus is a saprophyte and is not the cause of the disease. In the earliest stages the disease appears as a watery discoloration of the layer just beneath the cuticle. A little later this discolored area becomes covered with minute, sticky drops. These swarm with bacteria. Pure cultures of this germ will promptly produce the disease when introduced under the skin of a sound tomato. The disease cannot be induced by inoculating the flowers nor by smearing it on the surface of the fruit. When the same germ is introduced deeply in the tissues of the fruit, as by the boll-worm, it produces a watery rot.

The germ is non-spore-bearing, motile Bacillus. It is strictly äerobic. It grows readily on the surface of peptone agar and on boiled potato, feebly on raw potato and in milk. It fails to grow on strawberries, apples and cabbage. The disease is probably spread through the agency of some small insect. A species of Thrips has been observed in suspicious connection with it, but its agency in crossing it is not proved.

'On two hitherto confused species of *Lycopodium*,' Professor Francis E. Loyd spoke of *Lycopodium complanatum* and the so-called variety *chamæcyparissus*, having been found by the speaker in southern Vermont. A study of their characters shows them to be quite distinct, specifically.

'Some of the Investigations on Grasses and Forage Plants in Charge of the Division of Agrostotogy, U. S. Department of Agriculture,' were spoken of by Thomas A. Williams. He called attention more particularly to the field and coöperative experimental work now in progress in the West and South, and spoke of the need of varieties of grasses and forage plants better adapted to use on (*a*) Dry, arid soils, (*b*) Saline and alkaline soils, (*c*) High elevations. Promising forms for cultivation belonging to such genera as *Agropyron*, *Poa*, *Festuca*, *Bromus* and *Bouteloua* are being studied; also selected strains of such commonly cultivated sorts as timothy and Kentucky blue-grass. He asked the coöperation of those interested that the work may be furthered and bettered.

'The Wilting of *Cleome integrifolia*' was mentioned by Dr. C. E. Bessey, calling attention to the fact that when the plant is supplied with too little water its leaflets stand erect. 'The Powdery Mildew of *Polygonum aviculare*' was discussed by the same author, noting its earlier appearance this season, 1899, in Nebraska and the dwarfing effect in the host.

Dr. N. L. Britton presented 'Notes on the Northern Species of *Celtis*.' The speaker discussed the differential characters of *Celtis occidentalis* L. and C. *Crassifolia* Lam. as illustrated by trees in the vicinity of Columbus.

Dr. Britton also made 'Remarks on some Species of *Quercus*.'

Attention was called to the finely developed trees of *Quercus acuminata* about Columbus, both in its typical narrow-leaved form and in the numerous obovate-leaved trees; the character of bark and acorns of the two were commented upon.

'Ohio Stations for Lea's Oak' was the subject of a report by Dr. W. A. Kellerman. A fourth station in Ohio for Lea's Oak was discovered recently at Cedar Point, near Sandusky, Erie county. Two trees only were detected, and they were surrounded by many Black Oaks (*Q. velutina*), and still more numerously by the Shingle Oaks (*Q.*

imbricaria). Other species of oak occur on the Point. The two trees were a few rods apart; their trunks were about twelve and twenty inches in diameter. The other stations known are Cincinnati, Brownsville, Licking county (the tree cut down in 1892, but sprouts from the stump are growing), and Columbus.

'Labels for Living Plants' were likewise discussed by Dr. Kellerman. He exhibited a modified form of the printed label for living plants, already described before the Botanical Club. In these he uses a printed card label in metal holder covered by mica sheets of proper size. This label in suitable sizes is adapted to use in the greenhouse or out-of-doors.

Under the title 'The Introduced Species of *Lactuca* in Ohio,' A. D. Selby spoke of the recent discovery of plants of *Lactuca saligna* L., south of Dayton; this was first collected in 1898. This species has been studied during a second season and is clearly a distinct species from the pinnatifid-leaved forms of *L. Scariola* L. It is characterized by the slender, twiggy growth, the absence of spines and other minute characters. Photographs were shown to the club. This is seemingly the first recorded occurrence of *Lactuca saligna* in the United States. It seems liable to become widely dispersed.

The same author spoke of some peculiarities of the yearly reappearance of *Plasmopara Cubensis* (B. & C.). This happens in Ohio, usually August 12th to 20th, not earlier, though possibly later the present year. The explanation of this phenomenon was asked; it seems peculiar in the absence of known oöspores.

'What shall we regard as Generic Types?' was discussed by Dr. L. M. Underwood. He reviewed, in the light of his work on the ferns, the method of residues as applied to inclusive genera when they are separated. Another method was suggested, that of regarding the first described species under the genera as the type of the genus. The Linnæan or pre-Linnæan genera must in this method be studied from their pre-Linnæan history. Professor Underwood was inclined to support the latter method.

After a discussion of the paper it was unanimously *Resolved:* "That the question of the determination of generic types be referred to the Committee on Nomenclature, with the request that the Committee submit a report thereupon at the next meeting."

'A Brief Embryological Study of *Lactuca Scariola* L.' was presented by J. W. T. Duvel. This paper showed very briefly the development of the individual pollen grains from the chains of pollen mother cells. It likewise treated of the entrance of the pollen tube into the embryo sac, illustrating the ejection of the sperm nucleus and its union with the oöspore; this union usually takes place near the center of the embryo sac, though such union may take place adjacent in the pollen tube.

'The Position of the Fungi in the Plant System' was the subject of a paper communicated by Professor H. L. Bolley. He submitted that the reported growth of bacteria on a purely mineral medium would call in question the degenerate character of the group. But in his own work he had found that on cultures made by washing water-glass in running water and then in distilled water other fungi still flourished.

Professor A. D. Hopkins presented some 'Botanical Notes by an Entomologist.' He remarked upon the discriminating power of insects as between allied species of conifers, etc., and reported the occurrence of a Larix Swamp in West Virginia.

Professor L. C. Corbett exhibited and illustrated the use of 'A Device for Registering Plant Growth.' This had developed from the author's work a : Cornell University and in its completed form is a most satisfactory

instrument. It was exhibited at the request of Dr. J. C. Arthur, by whom the instrument is offered.

Professor O. F. Cook gave 'Notes on Some of the Work of the Division of Botany of the U. S. Department of Agriculture.' The investigations of poisonous plants and the resulting publications were noticed, also the work of the Seed Laboratory reporting upon the germinating power and purity (freedom from weeds and other adulterations) of commercial seeds. Variety tests, particularly of garden vegetables, including recent introductions from abroad are also in progress, and the use of a large tract of land on the Potomac Flats has recently been secured for the purpose. The Section of Seed and Plant Introduction is conducting the importations from abroad and has had, during the past year, agricultural explorers in Japan, Russia and the Mediterranean region. The introduction of new cereals, including rice, garden vegetables, dates and the fig insect (*Blastophaga*) are among the most important items secured. In connection with this work a collection of economic plants is a necessity and has been supplied by an herbarium of ecomomic plants.

Professor W. J. Beal told of the Botanical Club organized by the students and teachers of the Michigan Agricultural College. This has an order of procedure similar to the Botanical Club of the A. A. A. S. Dr. Beal also spoke of the introduction and persistence of *Cabomba Caroliniana* on the grounds of the Michigan Agricultural College.

Professor A. S. Hitchcock spoke of the peculiar distribution of several swamp plants in Kansas and illustrated by maps. Their scattered and unexpected occurrence was remarked upon. He also exhibited first-year results of certain wheat crosses.

Two or three other titles were passed, owing to the early departure or absence of the authors. At the close of the session of the Club on Thursday afternoon, N. L. Britton, A. S. Hitchcock and O. F. Cook, comprising the Committee on Nominations, reported, and the Club elected the following officers:

President—Professor F. S. Earle, Auburn, Alabama.

Vice-President—A. D. Selby, Wooster, Ohio.

Secretary—Professor F. E. Lloyd, New York City.

Upon motion, the cordial thanks of the Botanical Club were extended to Professor Kellerman for excellent arrangements; to the Local Committee of the Association for badges, and to the authorities of the Ohio State University for many courtesies enjoyed.

It was remarked by Dr. Britton that the twenty-seven titles of papers presented before the Botanical Club, those before Section G and those presented before the Botanical Society of America show a greater number than in any other science represented at the meeting. This he thought was an augury of widespread botanical activity; it also indicates that but for the affiliated societies Section G would have been overwhelmed.

On motion, the Club adjourned to meet at 9 o'clock Tuesday morning of the next meeting of the American Association for the Advancement of Science.

A. D. Selby,
Acting Secretary.

THE AMERICAN MICROSCOPICAL SOCIETY.

The twenty-first annual meeting of the Society was held in Columbus, Ohio, August 17th, 18th and 19th; and, though not largely attended, it was an occasion of good fellowship and enthusiasm.

Among the papers read and discussed were the following: An Expedient in Difficult Resolution, by R. H. Ward, Troy, N. Y. The Relation of Cancer to Defective

Development, by M. A. Veeder, Lyons, N. Y. Notes on Laboratory Technic, by S. H. Gage, Ithaca, N. Y. The Present Status of Scientific Bibliography, by Henry B. Ward, Lincoln, Nebr. The Reaction of Diabetic Blood to some of the Aniline Dyes, by V. A. Latham, Chicago, Ill. Notices of Some Undescribed Infusoria, by J. C. Smith, New Orleans, La. Modern Conceptions of the Structure and Classification of Diatoms, by Charles E. Bessey, Lincoln, Nebr. Comparative Structure of the Soft Palate, by W. F. Mercer, Ithaca, N. Y. A New Microscope Stand, by A. G. Field, Des Moines, Ia. The Eyes of Typhlomage from the Artesian Well at San Marcos, Texas, by C. H. Eigenmann, Bloomington, Ind. Methods Employed in the Study of the Chiasma of *Bufo vulgaris* by B. D. Myers, Ithaca, N. Y. Indexing, Cataloguing and Arranging Microscopical Literature and Slides, by R. H. Ward, Troy, N. Y. Notes on New Genera of Water Mites, by R. H. Wolcott, Lincoln, Nebr. *Notogonia Ehrenbergii*, Perty, by J. C. Smith, New Orleans, La. Limnobiology and its Problems, by Henry B. Ward, Lincoln, Nebr. The Plankton of Echo River, Mammoth Cave, by Charles A. Kofoid, Urbana, Ill.

One afternoon session was devoted to a symposium on the use of the microscope by teachers and private workers, in which the topic of Animal Histology was presented by Professor Gage, that of Bacteriology by Professor Bleile, and that of Botany by Professor Bessey. On Thursday evening the Society listened to the annual address of the President, Dr. William C. Krauss, of Buffalo, N. Y., on the subject: 'Some Medico-legal Aspects of Diseased Cerebral Arteries.'

The Treasurer's report showed that the Society closed the year practically even, and that nearly one hundred dollars had been added to the Spencer-Tolles Fund, making it now $653.36. When the fund reaches $1,000 it is expected to make use of the income for an annual prize or grant for microscopical research.

The following officers were elected for the coming year:

Professor A. M. Bleile, Columbus, Ohio, President.
Professor C. H. Eigenmann, Bloomington, Ind., Vice-President.
Dr. M. A. Veeder, Lyons, N. Y., Vice-President.
J. C. Smith, New Orleans, Treasurer.
Magnus Pflaum, Pittsburg, Pa., Custodian.
As elective members of the Executive Committee:
Dr. W. W. Alleger, Washington, D. C.
Dr. A. D. Kerr, Buffalo, N. Y.
B. D. Myers, Ithaca, N. Y.

The Society was tendered an evening reception by Mr. J. F. Stone, who showed a fine series of views taken on his trip through the Grand Cañon of the Colorado River. The local committee gave visiting members and ladies a trolley ride around the city, besides providing in many other ways for the success of the meeting.

HENRY B. WARD,
Secretary.

PROCEEDINGS OF THE SIXTEENTH ANNUAL CONVENTION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, HELD AT SAN FRANCISCO, JULY 5–7, 1899.

THE sixteeenth meeting of the Association of Official Agricultural Chemists was held in San Francisco, July 5th to 7th inclusive, under the presidency of Dr. R. C. Kedzie, Chemist of the Agricultural Experiment Station of Michigan. There was a large attendance of agricultural chemists, not only from the Pacific, but also from the Atlantic coast. On account of the early date at which the Association met, making only a little over eight months from the time of the last meeting, it was found that many of the referees and their collaborators had not the time or the opportunity in which to complete the work intrusted to them. Anticipating this difficulty, the Secretary, several weeks in advance of the meet-

ing, suggested to the referees that in lieu of their regular reports on the results of the prescribed analytical work, or in addition to these, they give a brief historical *résumé* of the progress of the subject assigned to each of them since the formation of the Association.

The Secretary of the Association adopted the suggestion also in his report, giving a historical report of the Association of Official Agricultural Chemists. In this sketch it was shown that the Association was formed as a result of a meeting called by the Commissioner of Agriculture of the State of Georgia in 1880. This convention met in the library of the Department of Agriculture in Atlanta, July, 1880, and organized by electing the Hon. J. T. Henderson, Commissioner of Agriculture for the State of Georgia, President. After several days spent in valuable discussion, the convention adjourned to meet in Boston, with the Association for the Advancement of Science, on the 27th of August, 1880.

The third meeting of this Association was held, in connection with the Association for the Advancement of Science, in Cincinnati, beginning August 18, 1881.

After the adjournment of the Cincinnati meeting the interest in the collaboration of the agricultural chemists seemed to die out. It was only after three years that the fourth meeting was called by Mr. Henderson. This meeting assembled in Atlanta, May 15, 1884. After three days spent in convention work an adjournment was made to meet again in September in Philadelphia, in connection with the Association for the Advancement of Science. It was at this meeting in Philadelphia that the Association assumed its present organization. The meeting was held September 8, 1884, Dr. E. H. Jenkins being elected Chairman. The name, Association of Official Agricultural Chemists, was adopted at this meeting and likewise the constitution, which has undergone very little change since. The formal organization took place September 9, 1884.

From that time to the present the Association of Official Agricultural Chemists has been under the patronage of the United States Department of Agriculture; its meetings have usually been held in Washington and its Proceedings have been published as bulletins of that Department.

At first the methods of analysis were incorporated with the Proceedings, but later they were collected together under a separate cover, in which form they are now published.

The successive Presidents of the Association have been as follows: S. W. Johnson, H. W. Wiley, E. H. Jenkins, P. E. Chazal, J. A. Myers, M. A. Scovell, G. C. Caldwell, N. T. Lupton, S. M. Babcock, E. B. Voorhees, H. A. Houston, B. F. Ross, Wm. Frear and A. L. Winton.

The President, Dr. Kedzie, gave an interesting address on the subject of foods and food adulterants. This address was read at the joint meeting of the Association of American Agricultural Colleges and Experiment Stations and the Association of Official Agricultural Chemists, immediately following the address of Dr. Armsby, of the first-named Association.

In the regular proceedings of the Association the report of the referee on potash was read by Mr. B. B. Ross, which included an historical account of the methods of analyzing potash since the formation of the Association. Mr. Ross also gave an interesting table showing the results of the comparative analyses of potash samples made during the preceding year.

On the second day a report was made by the referee on soils, Mr. B. L. Hartwell, of Rhode Island, giving the results of comparative studies of the composition of the soils from different parts of the country and by the different methods of determination.

The report of the referee on foods and feeding stuffs, by Thorn Smith, was read by the Secretary, in the absence of the referee and his associate.

The report of the referee on insecticides and fungicides was read by Mr. L. A. Voorhees, the associate referee, and was a very interesting contribution to a branch of chemistry which, so far, has received comparatively little attention.

The report on dairy products was read by the referee, Mr. J. B. Weems, and added much to that branch of agricultural chemistry.

The referee on phosphoric acid, Mr. E. G. Runyan, presented a report summarizing the progress which had been made in the methods of determining phosphoric acid during the fifteen years of the existence of the Association. Especial attention was given to the development of the volumetric method, whereby the processes for estimating phosphoric acid in its usual forms are greatly shortened without any impairment of accuracy.

A similar paper relating to the determination of nitrogen was presented by Mr. F. S. Shiver, the referee on this subject.

The report of the committee on food standards was read by Mr. Frear. The report shows the method in which the work has been divided among the various subcommittees and the character of the subjects assigned to each committee. Great progress has already been made in the study of the data which must be considered in fixing food standards, and, from the amount of work which has already been accomplished, it is evident that in a very short time the Association will be in possession of a series of food standards which are based upon the most reliable data obtainable. The value of such a set of standards, especially from a legal aspect, is extremely great. One great difficulty in the enactment of pure food laws heretofore has been the incompleteness in the standards of purity. The final result of the work of the Association in this respect will be such as to warrant the acceptation and the adoption of these standards in the municipal, State and national legislation enacted in the interest of pure food.

The officers which have been elected for the ensuing year are:

President: Mr. B. W. Kilgore, North Carolina.

Vice-President: Mr. L. D. Van Slyke, New York.

Secretary: Mr. H. W. Wiley, Washington, D. C.

Additional members of the Executive Committee: Messrs. M. E. Jaffa, California; Arthur Goss, New Mexico.

H. W. WILEY.

A CARD CENTRALBLATT OF PHYSIOLOGY.

IN SCIENCE for September 1, 1899, it is stated "that the Boston Public Library will undertake the printing of a card catalogue of physiology, the cards to contain not only the ordinary bibliographical information, but also brief abstracts of the papers. The plan originated in the physiological department of the Harvard Medical School, and Professor W. T. Porter will be responsible for securing or preparing the abstracts."

This statement is inexact, and if allowed to go uncorrected would be certain to harm a useful undertaking. For this reason it seems best to give at once the details of the proposition now being considered by the Trustees of the Boston Public Library. I am the more concerned to have these details correctly understood, because the proposed method of making the literature of physiology more accessible is not limited to that science, but may be extended to all sciences, the literature of which is sufficiently compact to warrant the publication of a Centralblatt.

The need of rapid and easy access to the stores of science increases daily. The in-

vestigator is much hampered by the difficulty of collecting all the references to the work in hand, scattered as they are through large and diffuse literatures; the university lecturer finds his utterances become more fragmentary every day; and as for the advanced student, he is often dismayed by the mere account of what must be done in order to be certain of the real state of opinion concerning the subject that interests him; in fact, we are likely to be crushed under the pressure of discoveries, old and new. The present *Centralblätter* and the *Jahresberichten*, excellent as they are, afford but scant relief. In every instance the seeker must examine the indexes of a long series of volumes, and these indexes are commonly the not too laborious creation of men uninstructed in cataloguing. Indexes, moreover, are usually put together from the titles of papers, and titles rarely give a sufficient idea of the the whole contents.

But it is not my intention to write of the dark side of productiveness. The danger of swamping in the sea of literature is patent to every one. In several countries relief is being sought by the issue of card indexes. These remedial measures are alike in that they offer the titles of scientific communications, each printed on a single card, intended to be placed in an author's catalogue, *i. e.*, a set of cards arranged alphabetically by the names of authors. This function they might carry out very well, if they were printed and distributed with sufficient promptness.

Besides the author's name, and the title, date, and place of publication, some additional information usually is printed on the card so that duplicate cards may be arranged as a subject catalogue, *i. e.*, filed alphabetically according to subject. The efforts toward a subject catalogue, so far as I am acquainted with them, fall into three groups. In the first, it is proposed to give, besides the data already mentioned, a number of cross-references, in other words, a list of matters treated by the author; this, if I am correctly informed, is essentially the intention of the Royal Society. The second method proposes a few lines of text furnished by the author himself and stating his principal results; this was proposed by Professor H. P. Bowditch. The third consists of a few lines of contents, written by a cataloguer.

Any of these catalogues is undoubtedly much more useful than a bare title. From none of the three, however, can the investigator receive a satisfactory idea of the results of his predecessors. The cross-reference card is a simple index, and nothing more; the others, by reason of too great brevity, are not much better. Of the second and third method, I have some personal experience. The *American Journal of Physiology*, at Dr. Bowditch's suggestion, undertook a practical demonstration of his plan. An 'index slip' was issued with each number of the *Journal*. The slip contained the author's name, date, title and place of publication of each article in the number, and a statement of results of not more than 150 words.

Authors were invited to write their own statements. The slip was printed on thin paper, so that each statement could be cut out and pasted on a library card. In editing the slip for the *Journal*, I found that the results of many investigations could not be stated in the space allowed; in such cases investigators objected with right that the too brief statement was misleading. It appeared further that nearly all the 'copy' received from contributors had to be partially rewritten; the author who had just filled many a broad octavo page could not shrink within the limits of the library card. A number of slips I had to write myself, because the authors failed to send any statement whatever, or sent them after the slip had gone to press. I believe that the

handling of the whole current physiological literature by this method of coöperative authors would hardly be practical for the reasons already hinted ; because a proper account of many a research cannot be given in the space of one library card, and an imperfect account wrongs the author and deceives the reader ; and because it would be far from easy to persuade each year more than a thousand authors to send in suitable 'copy' with sufficient promptness ; certainly many authors would refuse, and thus a considerable number of the cards would after all be written by the editor, who could not have first-hand knowledge of all the subjects of which he wrote.

These same objections apply also to the third method mentioned above, that of a card written by a cataloguer. The lack of space and the impossibility of really expert knowledge of all chapters in so wide a science are fatal to the best results.

These difficulties led me naturally to the idea of a Centralblatt printed on cards. In a properly organized centralblatt, the abstracts are as long as may be necessary to do justice to the author's results, and each abstract is written by an expert in the field in which the original investigation lies. The advantage of having such abstracts printed on library cards is plain. The original set, arranged alphabetically by authors' names and chronologically under each author, would give the principal results of each investigator throughout his whole career. Duplicates arranged according to cross-references printed in the upper and lower margin of each card would furnish not only a chronological list of the investigations on any particular subject, for example, on the chemical reaction of the gastric juice, but would without further search set forth the fruits of the studies mentioned. Certainly none of the methods already described approaches this one in usefulness, and its wide adoption should follow quickly on the demonstration of its practicability. This demonstration was furnished in the proposition made by me to the Trustees of the Boston Public Library.

By this proposition the Library would print on cards a Centralblatt of Physiology to be issued under the direction of a professional physiologist. The actual cost of printing is guaranteed. Thus the Library, secured from loss, would allow the manufacture on its premises of an apparatus devised to make knowledge more accessible—the end for which the Library itself was created. This permission would be valuable, because the Boston Public Library is at present better equipped for such an undertaking than any other library,* here or abroad, and because the cost of manufacture by such an institution includes neither commercial risk nor commercial profit.†

It is agreed that this card Centralblatt shall contain abstracts of original communications in physiology, including physiological chemistry, invertebrate physiology and the physiological action of drugs. Each abstract is to be written by a physiologist specially learned in the field in which the original belongs. Wherever possible the abstract is to be the work of the author himself, following the admirable suggestion of Dr. Bowditch. Abstracts are to be mailed to subscribers about three weeks after the appearance of the original in this country, and in six weeks in the case of communications published abroad. Taking an average of the abstracts in a volume of the *Centralblatt für Physiologie* and the *Jahresbreicht über die Fortschritte der Physiologie* as a guide, it is expected that 1,500 to 1,700 abstracts, requiring in all

*The most valuable part of this equipment is the skill of Mr. Francis Watts Lee, the accomplished head of the Printing Department. I am indebted to Mr. Lee for much practical information.

†The cost of issue by a commercial house not specially equipped for such work would be between $3,200 and $3,500.

about 2,000 cards of standard library size would be printed annually. The issue would be fortnightly. Each card would contain the author's name; the title; the date and place of publication; the abstract; the name of the expert writing the abstract; two cross-references, each with reference numbers according to the Dewey system; and, finally, the special data required by the mailing law. Composed in linotype brevier, a clear, easily read type, the space available for the text of the abstract would hold about 225 words. The average length of abstracts in the *Centralblatt für Physiologie* is about 200 words. Where the abstract is too long to be printed on one card, a second, or a third, would be used. A thousand cards will "bulk" nine inches.

The regular issue would consist of an original and two duplicate sets. The original set could be arranged alphabetically by the names of authors. The duplicates could be arranged by subjects, with the aid of the cross-references or the Dewey numbers. Suitably printed guide cards, and filing boxes of stout cardboard, the corners strengthened with metal, would be furnished. The price per year, *i. e.*, for about 6,000 cards, with sufficient printed guides and filing boxes, would be ten dollars, postage free, to subscribers in the United States and Canada, and twelve dollars and a half to foreign subscribers, the additional charge being the excess of foreign over domestic postage.

It is agreed that no charge would be made for editorial and business management, that the remuneration of the writers of abstracts would be merely nominal, and that any excess of receipts over expenditures would be applied toward increasing the value or diminishing the price of the publication to the subscriber. Scientists are obliged to collect all the literature of their special subjects. It is believed that the additional labor of putting these gleanings in shape for publication will be repayed in large part by the general saving of time and trouble which the new publication would undoubtedly effect. Besides, the work is a public service.

It has already been said that the Trustees of the Boston Public Library have not yet acted finally upon this proposition. In the event of their deciding that the Library shall not increase its usefulness in this particular direction, it is hoped that means will be found of printing elsewhere. The success of this undertaking in physiology would mean the issue of similar publications in other sciences and the saving of much valuable time now wasted in unprofitable rummaging.

WILLIAM TOWNSEND PORTER.
HARVARD MEDICAL SCHOOL, September 7th.

SCIENTIFIC BOOKS.

The Soluble Ferments and Fermentation. By J. REYNOLDS GREEN. Cambridge. 1899. Pp. 438. [From the Biological Series of Cambridge Natural Science Manuals.]

Enzymology, or the science of the soluble ferments, is a rapidly growing branch of physiological science. Numerous observations bearing upon it are so widely scattered through chemical, botanical, bacteriological, physiological and other journals that it is somewhat difficult to follow its progress and make a systematic summary of the subject. The books thus far published do not treat the entire subject from a physiological aspect. The work of Gamgee, published in 1893, on the chemistry of digestion, is intended especially for the *physician* and treats very ably the enzymes of the animal body, while the work of Effront, *Les enzymes et leur applications*, published in 1896, has especially the *technical* side in view, although it does not neglect the purely chemical details of recent investigations. Reynolds's book attempts more; it undertakes not only to give a detailed description of the enzymes and their actions, but also to bring before us all the physiological relations in plants and animals. It is divided into twenty-four chapters. The first treats of the nature of fermentation and

its relation to enzymes. Chapters I. to IX. treat of enzymes acting upon various carbohydrates; they comprise diastase, maltase, inulase, cytase and others. Chapter X. considers the glucoside-splitting enzymes, as emulsin, myrosin, rhamnase and others. Chapters XI., XII. and XIII. treat of proteolytic enzymes, as pepsin, trypsin, papain, bromelin, etc. Chapter XIV. describes the fat-splitting enzymes, and the following three chapters the clotting enzymes, rennet, thrombase and pectase. Then follows urease and hystozym. Chapter XIX. is devoted to the oxidizing enzymes, and Chapter XX. to the alcoholic fermentation. Chapter XXI. treats of the fermentative power of protoplasm, Chapter XXII. of the secretion of enzymes, Chapter XXIII. of the constitution of enzymes, and Chapter XXIV. of the theories of fermentation.

In the preface and first chapter the author defines his own position in regard to views on fermentation. He lays stress on the relations between "fermentation in the broad sense and the general metabolic phenomena of living organisms." Recent discoveries "have shown more and more plainly what a prominent part is played by enzymes in intracellular metabolism, till it has become clear that the distinction drawn between organized and unorganized ferments is based upon an incomplete acquaintance with the metabolic processes in both higher and lower organisms, and must now be abandoned entirely in the light of fuller knowledge." He defines consequently fermentation to be the "decomposition of complex organic material into substances of simpler composition by the agency either of protoplasm itself or of a secretion prepared by it."

While this general view hardly requires any further comment, grave doubts may be expressed as to the correctness of his general view on the characteristics of protoplasm. The author adopts the views of Pflüger and Detmer, and believes in its "continually undergoing decomposition and reconstruction." This decomposition can, however, continue for only a short time, as otherwise death would result before reconstruction could take place. To explain the principles of life as a perpetual destruction and reconstruction of protoplasm shows very erroneous conceptions. The material destroyed in the process of life consists of 99 per cent. of carbohydrates, fats and passive proteids of the food, but not of the living matter itself. The general descriptions in Green's book of enzymes and their physiological relations correspond to the relations of the plant physiologist. We find in Green's book excellent paragraphs on diastase of secretion and diastase of translocation; on the condition of secretion of diastase and the condition of the action of diastase; on cellulose, dissolving enzymes, and on vegetable trypsins. But wherever the progress of modern *chemistry* comes into play the physiological chemist will hardly be satisfied. The author ignores the principle of chemical *lability* of the proteids of living matter and in enzymes, by which property heat can be converted into mechanical energy.

The author has overlooked further certain points in recent chemical literature; otherwise he would not have mentioned (p. 168) antipeptone as a chemical substance. Recent investigations have placed beyond doubt the fact that the so-called anti-peptone is no peptone at all, but essentially a mixture of several bases, viz., arginin, lysin, histidin.

Further, Green mentions on page 174 the artificial production of an albumin from peptone by acetic anhydride, although it was shown several years ago that in this way merely an acetyl peptone, but no true albumin, is obtained.

In regard to the preparation of diastase Green describes several methods, but not without making various errors. In the first place he calls the method which makes use of basic acetate of lead for the isolation of enzyme Loew's method, while it was Wurtz who applied this method first and with great success in the isolation and purification of another enzyme papain.*

In the second place Green calls this method untrustworthy, although he did not control it by a single experiment, but merely relied upon the judgment of a young chemist, who in the first investigation he had ever published failed to obtain a powerful diastase. This was, however, due to the fact that he had not yet ac-

* *Comptes Rendus*, 90, 1379 and 91, 787

quired the necessary skill and had disregarded necessary precautions for the treatment of such a delicate substance as diastase. In the third place Green gives a detailed account of Loew's method for the preparation of diastase which is totally *erroneous*, since neither calcium salts nor caustic soda nor acetic acid mentioned in that description has ever been used in this method. Further, the diastase was not obtained from the precipitate produced by basic lead acetate, as Green states, but from the filtrate of that precipitate. Those readers who wish to compare the method in question with Green's remarkable translation are kindly referred to Pflüger's Archiv, Vol. 27, p. 206.

Another erroneous statement is found on page 113. We read there: "Invertase has been described by Atkinson and by Kellner, Mori and Nagaoka as existing in rice and in Koji, a peculiar preparation of that cereal which is much used by the Chinese in the preparation of fermented liquids." The statement that the authors noted had found invertase in *rice* is incorrect. They have found it in Koji, which consists of a growth of *Aspergillus oryzæ* on *boiled* rice, and, as these authors have proved, it is that fungus which contains the invertase, and not the rice in which this enzyme could hardly have been suspected. Further, it might be mentioned that the Japanese make relatively as much use of Koji as the Chinese.

As to the names adopted for new enzymes it may be mentioned that in Chapter IX. the name *glucase* is used for the enzyme which splits maltose into two molecules of glucose. Various chemists, however, have agreed that for the sake of uniformity the new enzymes should be named after the compound acted upon and not after the compounds resulting from this action. Consequently, the name *maltase* and not *glucase* is now in universal use with physiological chemists, which name, however, is only once mentioned in parenthesis in Green's book. In the chapter on the oxidizing enzymes we find detailed accounts of various investigations on laccase, tyrosinase, oenoxidase and animal oxidases. One very essential point, however, has been overlooked by Green, namely the distinction between oxidases and peroxidases, the former yielding *directly* a blue color with dilute guaiac tincture* in presence of air, the latter only in presence of hydrogen peroxide. The former are, therefore, to be considered as the more powerful, since the rather *indifferent* oxygen of the air can be brought into action by them, while the peroxidases want, at least in their action upon guaiaconic acid and some other compounds, —oxygen in *statu nascendi*, *i. e.*, oxygen in a state of motion or charged with kinetic chemical energy. That hydrogen peroxides is generally decomposed by enzymes with liberation of oxygen is known and this oxygen in *statu nascendi* is more powerful than the common oxygen of the air.

In the very ably treated chapter on the secretion of enzymes we miss the investigations of Bruno Hofer, who was the first who demonstrated the direct connection of the nucleus with the formation of the enzymes.

On page 370 an erroneous conception is ascribed to Nägeli. He never entertained the opinion that the chemical powers of the enzymes are essentially different from those of the fermenting organisms. He supposed also in the enzymes certain motions (although less energetic ones) to be the cause of their actions, and defended this view against Kunkel.† The quoting of Fischer by Green is entirely unjustifiable in this connection.

In the interest of a future edition of Green's book, which would gain by a little less bias we mention the following typographical errors:

On page 49, line 32 for Grüber, read Gruber.
" " 87, " 16 " Ganz " Gans.
" " 100, " 22 " " "
" " 113, " 22 " Nagaoko " Nagaoka.
" " 273, " 17 " Mallevre " Mallvère.
" " 288, " 28 " Schmiedeburg read Schmiedeberg.
On page 340, line 15 for Pfluger read Pflüger.
" " 177, " 37 " Loew's method read Wurtz's method.

Notwithstanding some unjustifiable remarks and some erroneous chemical statements, the

* Guaiac tincture is a very valuable reagent in the hands of a cautious chemist who discriminates and controls. It is unreliable only in the hands of untrained persons. Above all, it has to be frequently renewed and to be kept cool in the dark.

† Sitzungsberichte der Bayrischen Akademie der Wissenschaften, 1880, p. 385.

book is a valuable contribution to the scientific literature of the subject. It can be well recommended to students of physiological science. Teachers will find in the practical arrangement of the book and in the summaries of views only to be found in widely scattered publications, a welcome guide for arranging their lectures on this subject. Investigators, however, will always prefer to consult original contributions rather than text-books or handbooks.

OSCAR LOEW.

U. S. DEPARTMENT OF AGRICULTURE.

Annals of the South African Museum. Volume I. Part 2. March, 1899.

The first of the papers (V. in the series) in this volume is 'On the Species of Opisthophthalamus in the Collection of the South African Museum, with Descriptions of Some New Forms,' by W. F. Purcell. The treatment of the genus is brought to a conclusion, three new forms are described, and the localities and local peculiarities of the specimens, numerous in the collection, are given at some length. In conclusion, the synopsis of all species known to the author, begun in a previous paper, is brought to completion. Article VI. is a 'Descriptive List of the Rodents of South Africa,' by W. L. Sclater, and is published as preliminary to a greater work on South African mammals. The genera are arranged according to the list published by Oldfield Thomas in the *Proc. Zool. Soc.* for 1896, and 62 species are mentioned, one *Malacothrix pentonyx* being new.

Article VII.—'Fifth Contribution to the South African Coleopterous Fauna,' by L. Péringuey, is devoted to the description of new Coleoptera, mostly in the collection of the museum.

Article VIII.—'On the South African Species of Peripatidæ in the Collection of the South African Museum,' by W. F. Purcell, gives full descriptions of the external systematic characters of three out of the four previously described species, with descriptions of four new species. These are *Peripatopsis leonina*, *P. sedgwicki*, *P. clavigera* and *Opisthopatus cinctipes*.

Article IX.—(by a misprint given as X.), 'A Contribution to the Knowledge of South African Mutillidæ,' by F. Péringuey, describes 26 new species. This brings the number of South African species of this family to 169, but the number of which both sexes are definitely known is only 16.

The final paper X.—'Description of a New Genus of Perciform Fishes from the Cape of Good Hope,' by G. A. Boulenger, describes and figures *Atyposoma gurneyi*.

F. A. LUCAS.

A Catalogue of Scientific and Technical Periodicals, 1665–1895. HENRY CARRINGTON BOLTON. City of Washington, Smithsonian Institution, 1897. Second edition, pp. vii + 1247.

The first edition of Dr. Bolton's catalogue, issued in 1885, has been a great aid to scientific men and to scientific research, and a second edition, with many additional titles and much revision, is very welcome. The former edition contained the titles of 4,954 periodicals, and the present edition adds about 3,600 new titles, and gives further information in regard to many of the periodicals described in the first edition. Regarding all these journals full details are given—the date of establishment, the number of volumes issued, the place of publication, the editors, etc., including a history of the vicissitudes undergone by so many scientific journals. Over 200 pages are added, giving chronological tables, a subject index, and a check-list, showing in what American libraries the more important periodicals may be found.

The first part of the alphabetical catalogue is reprinted from the plates of the first edition with certain corrections. Then in the second part are the additions that could not be inserted in the plates and the new titles. This double alphabetical index is very inconvenient. It may indeed be reasonably claimed on various grounds that stereotyping is an invention for the retardation of science. The volume appears to be remarkably free from typographical errors in spite of the difficult proof reading, but it is not free from errors in compilation. Thus if we take the three leading American journals of general science, we find it said (referring to 1895), that the *American Journal of Science* is edited by 'James D. and E. S. Dana and B. Sillimann.' The *American Naturalist* is said to

be edited by 'A. S. Packard, Jr., and Edward D. Cope.' SCIENCE is said to be edited by a committee consisting of 'S. Newcomb, I. Remsen, O. C. Marsh, C. H. Merriam, J. W. Powell.' There are also serious omissions, *e. g.*, *The Bulletin of the American Mathematical Society* and the *Bulletin of the Torrey Botanical Club.*

The value of this compilation to the scientific worker is so great that the destruction by fire of the plates and sheets would not be regretted if this should lead to a new edition.

J. McKEEN CATTELL.

GENERAL.

THE newly formed Harper-McClure combination of New York City announces the publication of an encyclopædia which is intended to surpass even the Encyclopædia Britannica in range. It is to be hoped that the scientific articles will be entrusted to men of science as competent as the writers for the *Britannica.*

MESSRS. D. APPLETON & CO. announce for early publication the 'Comparative Physiology and Morphology of Animals,' by Professor Joseph Le Conte, and 'The International Geography' by Nansen, Markham, Bryce, Davis and others.

MESSRS. HARPER & BROTHERS have in press the 'Elements of Physics,' by Professors J. S. Ames and H. A. Rowland of the Johns Hopkins University.

BOOKS RECEIVED.

A Manual of Psychology. G. F. STOUT. London, W. B. Clive; New York, Hinds & Noble. 1899. Pp. xvi + 643.

Text-book of Vertebrate Zoology. J. S. KINGSLEY. New York, Henry Holt & Company. 1899. Pp. viii + 439.

The Teaching Botanist. WILLIAM F. GANONG. New York and London, The Macmillan Company. 1899. Pp. xi + 270.

The Elements of Blowpipe Analysis. FREDERICK HUTTON GETMAN. New York and London; The Macmillan Company. 1899. Pp. ix + 77. 60 cts.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology. May–June, 1899. Vol. VII., No. 4. The number opens with a symposium of three papers dealing with the Permian of the states west of the Mississippi. C. R. Keyes writes of the 'American Homotaxial Equivalents of the Original Permian,' pp. 321–342. A comparison is drawn between the American Permian and that of Russia as seen by the author during a recent Russian trip. C. S. Prosser follows with a paper on 'Correlation of Carboniferous Rocks of Nebraska with those of Kansas,' pp. 342–357. The author determines the relations of the Nebraska Carboniferous with the horizons which had been previously established by his careful, faunal studies in Kansas. W. C. Knight, 'The Nebraska Permian,' pp. 357–375. The writer's conclusions are that the Kansas Permian extends as a triangular area northward into Nebraska. Some tablesof fossils are given W. H. Hobbs, 'The Diamond Fields of the Great Lakes,' pp. 375–389. All the known finds of diamonds in the drift of the region of the Great Lakes are recorded and plotted with the intention of locating their probable source and home, and of arousing interest in the subject. W. H. Turner, 'Replacement Ore Deposits in the Sierra Nevada,' pp. 389–401. A number of gold-bearing deposits in California are described, which are in contrast with the usual quartz veins and which give ground for an explanation by replacement. Editorials, reviews, and a valuable summary of current North American Pre-Cambrian literature by C. K. Leith conclude the number.

THE *Educational Review* for September opens with an address given by Dr. W. T. Harris before the recent meeting of the National Educational Association, outlining an education policy for our new possessions, and an article on the educational progress of the year by Professor Nicholas Murray Butler, presented to the National Council of Education. The number also contains articles on the educational system in Chicago, women in the public schools, English in Regents' schools and the teaching of German in Germany.

DISCUSSION AND CORRESPONDENCE.

THE PROPER NAME OF THE POLAR BEAR.

TO THE EDITOR OF SCIENCE: Under this heading in SCIENCE for August 15, 1899, Mr. James A. G. Rehn states that the name of the Polar Bear should be *Thalarctos marinus* (Pal-

las), giving as the reason that Linnæus did not give the name *Ursus maritimus*, as usually attributed to him, and that "the next date when any mention of the Polar Bear was made was 1776, when Müller and Pallas each gave it a name." Allow me to suggest that Mr. Rehn's statement is not correct. It is true that Linnæus did not give a binomial term to the Polar Bear, but it is not true that it did not receive one until 1776.

In 1773 Sir C. J. Phipps undertook a voyage to Spitzbergen, and in the account which he published in 1774* the Polar Bear, with full references to Linnæus and Pennant and measurements from specimen, is formally named *Ursus maritimus*. I have not now at hand the original edition, and consequently cannot quote the page, but I possess the French translation of 1775,† in which the name occurs on p. 188. I may add that Mr. Rehn's is not the first attempt at resurrecting Pallas's name. It was done as early as 1844 by Keyserling and Blasius, who have been followed, among others, by Nilsson and Pleske. But the name of the Polar Bear should be *Thalarctos maritimus* (Phipps).

LEONHARD STEJNEGER.

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C., August 26, 1899.

*Phipps (C. J.). A voyage towards the North Pole undertaken by H. M's command, 1773. London, 1774. 4to.

† Voyage au Pole Boréal, fait en 1773 * * * etc. Paris, 1775. 4to.

THE MENTAL EFFECTS OF THE WEATHER.

IN reading the interesting article by Dr. Dexter in SCIENCE of August 11th under the above heading two or three suggestions as to the causes in action occurred to me and are perhaps worth mentioning. Dr. Dexter's curves show that the greatest number of assaults occur between the temperatures of 50° and 90° F., with a maximum between 70° and 80°. There is a greater number on clear and partly cloudy days than on days with rain. In other words, the conditions which we know attract people out of doors and bring them in contact are the conditions which, it appears, produce the greatest number of assaults and thus, perhaps, are indirectly the cause of them. Even the slightly greater number of assaults on partly cloudy days than on clear days may be interpreted from this standpoint. The partly cloudy days average warmer than the clear days, and people are more attracted out of doors on mild days than on cold days.

The number of errors in banks is found to be greater on cloudy and on rainy days than on clear days. This may be due to the greater amount of light on clear days by means of which the figures are more clearly seen.

The number of people insured appears to be less on rainy days. Again, this may be explained by a tendency of rainy days to keep people in doors. A man having decided to have his life insured on a certain day which proves to be rainy postpones it to a pleasant day, when traveling is more agreeable.

The increased energy which people feel on sunny days also no doubt contributes to the effects described above, as suggested by Dr. Dexter.

The number of deaths he found to increase with the temperature when the temperature was above 80°, and in this case there is probably a direct relation of cause and effect.

H. HELM CLAYTON.

BLUE HILL METEOROLOGICAL OBSERVATORY,
September 5, 1899.

NOTES ON PHYSICS.

PHOTOGRAPHY OF SOUND WAVES.

PROFESSOR R. W. WOOD publishes in *Phil. Mag.*, August, '99, some very interesting photographs of sound waves, taken by a modification of the method of Toepler. A telescope objective pointed at a star appears as a uniformly illuminated field to an eye situated at or a trifle behind its focus, inasmuch as light enters the eye from every part of the objective. A condensed mass of air between the lens and the focus turns the light which passes through it to one side of the focus; this deflected light may be cut off by means of a screen, the edge of which just grazes the focus, and the portion of the field of view which is covered by the condensed mass of air appears dark. Instead of the eye an ordinary photographic camera may be focussed upon the telescope objective, and by using the light from an electric spark, instead of

the light from a star, an instantaneous photograph may be taken of a sound wave moving across the field of view.

Professor Wood has in this way obtained photographs showing the wave-front forms which occur in various cases of reflection, refraction and diffraction. An auxiliary electric spark is employed as a source of the sound waves to be photographed.

THE HYDROLYSIS OF STANNIC CHLORIDE.

SOLUTIONS of stannic chloride show abnormally low freezing points. Mr. Wm. Foster* has shown that this abnormal behavior is to be ascribed to the hydrolysis of the stannic chloride, namely, the formation of HCl and stannic oxide, so that in dilute solution there is slowly formed four dissociated molecules of HCl instead of one dissociated molecule of $SnCl_4$. The freezing-point constant calculated upon this assumption is 14.06 and the value observed by Loomis is 14.25.

THE SPECIFIC HEAT OF SOLUTIONS.

PROFESSOR MAGIE † has shown theoretically that the heat capacity of a solution of a non-electrolyte, osmotic pressure being proportional to the absolute temperature, is the sum of the heat capacities of the solvent and of the solute, and he has derived an expression for the change in heat capacity of any solution due to change in concentration when the relation between osmotic pressure and temperature is given.

In case of non-electrolytes the above-mentioned relation is verified by experiments of Marignac and by more acurate measurements carried out by the author. Professor Magie points out that sufficient data are not at present at hand to verify the more general relation mentioned above.

MAGNETISM AND STRETCH-MODULUS OF STEEL.

STEVENS and Dorsey ‡ have shown that the stretch modulus (Young's modulus) of iron and steel is very slightly increased by magnetization in the direction of the stretch.

W. S. F.

* *Physical Review*, IX., p. 41.

† *Physical Review*, IX., p. 65.

‡ *Physical Review*.

*THE BACILLUS ICTEROIDES AS THE CAUSE OF YELLOW FEVER.**

Sanarelli reproaches me with not being willing to yield to the evidence in favor of the specific etiological rôle of his bacillus. I am not influenced in my scientific conservatism by any feelings of jealousy, and shall be ready to do full honor to the discoverer when the discovery is definitely established. At present I cannot admit this for the following reasons :

First. Sanarelli's bacillus grows readily in the culture media employed by me in my researches, but in nineteen typical cases of yellow fever in which I introduced into such media blood from the heart of yellow-fever cadavers, this bacillus was not present, the cultures remaining sterile in fifteen. In three of the four cases in which a growth occurred, I identified the bacillus found as bacillus coli communis (my bacillus *a*). I strongly suspect that some of those bacteriologists who claim to have found Sanarelli's bacillus have mistaken for it one of the varieties of the colon bacillus.

Second. In my experiments material from the interior of the liver and kidney, containing blood and crushed tissue elements from fresh cadavers, was added to culture media in which Sanarelli's bacillus readily grows, but I obtained a negative result (cultures remained sterile) in 30 out of 43 cases.

Third. Sanarelli's bacillus is fatal to guinea-pigs and rabbits when injected subcutaneously in very minute doses. In my experiments blood from the heart and crushed liver tissues from the fresh cadaver failed to kill eight out of ten guinea-pigs and seven out of eight rabbits experimented upon. I admit that the value of these experiments is impaired by the fact my laboratory facilities did not permit me to keep these animals under observation as long as was desirable.

Fourth. The experiments made by Drs. Reed and Carroll at the Army Medical Museum, show that Sanarelli's serum in high dilutions, (1–100,000) causes arrest of motion and typical agglomeration (Widal reaction) of theb acillus of hog cholera ; also, that serum from an animal immunized against hog cholera, in high dilu-

*From a reply to Professor Sanarelli, by Dr. George M. Sternberg, published in the *Medical News*.

tions, causes arrest of motion and typical agglomeration of Sanarelli's bacillus; also, that cultures of Sanarelli's bacillus fed to pigs cause the death of these animals, and that the typical lesions of hog cholera are found in their intestine.

Fifth. The blood-serum of yellow fever patients or of convalescents from this disease does not give a marked Widal reaction with Sanarelli's bacillus, although the blood of an animal immunized by the injection of cultures of this bacillus does give the specific reaction in high dilution.

Sixth. So far as I am informed the results obtained in the use of Sanarelli's antitoxic serum do not give support to his claim to have discovered the specific germ of yellow fever.

In a letter dated January 20, 1899, my friend Dr. J. B. de Lacerda, of Rio de Janeiro, says:

"The serum of M. Sanarelli has failed here in Brazil. The results of the experiments which he made at San Paulo have not recommended the employment of this serum. It is neither preventive nor curative."

In a paper recently published in the *New Orleans Medical and Surgical Journal*, Dr. P. E. Archinard reports a negative result from the use of Sanarelli's serum in ten cases. He says:

"From the above cases, which limit our experience with the anti-amarylic serum of Sanarelli as a curative agent in the human being attacked with yellow fever, we are forced to conclude that this agent, in our hands, has shown no curative powers whatsoever, none of the important and dangerous symptoms of the disease having been in any way mitigated or prevented by its administration."

Drs. Reed and Caroll are now preparing a report of their extended researches, which have been going on at the Army Medical Museum during the past two years. This report will be published in due time and will give full details as to the experimental evidence upon which they base their conclusion that Sanarelli's bacillus is a variety of the bacillus of hog cholera.

Finally, I would say it appears to me at the present time that, like the colon bacillus and bacillus x, the bacillus of Sanarelli is a pathogenic saprophyte which is present occasionally and accidentally in the blood and tissues of yellow-fever patients, and that its etiological relation to this disease has not been established. If, however, the results reported by Drs. Reed and Carroll can be shown to be based upon erroneous observations, I shall be ready to revise my opinion. Truth is mighty and no doubt in the end will prevail.

INTERNATIONAL CONGRESS ON TUBERCULOSIS.

The report of Sir Herbert Maxwell, M. P., F.R.S., and Dr. Pye-Smith, F.R.S., the delegates of the British government at the International Congress on Tuberculosis held at Berlin from May 24th to 27th last, has been issued as a Parliamentary paper. The report states, as abstracted in the London *Times*, that the Congress, which was opened by the Herzog von Ratibor, in the presence of the German Empress, consisted of 180 delegates, appointed by and representing different states and universities and other public bodies. A number of papers were read, chiefly by German delegates, but nothing in the nature of a general discussion took place. The proceedings when printed will form a valuable *corpus* of scientific opinion on the subject.

Dr. Pye-Smith adds a memorandum on the medical aspect of the results of the Congress. After giving in some detail the most important conclusions which were recognized—that consumption and other tubercular diseases are caused by the presence and multiplication of the specific bacillus discovered by Professor Koch; that tuberculosis, as a condition directly transmitted by inheritance, is extremely rare; and that phthisis, or pulmonary tuberculosis, in particular, is not catching—Dr. Pye-Smith goes on to describe the following practical points in the prevention of tuberculosis as a widespread and destructive disease which were inculcated by various speakers at the Congress:

A. The primary importance of free ventilation and wholesome and abundant food. Improvement in the dwellings and the food of the poorer classes in this country, and their increasing cleanliness and sobriety, have not only diminished sickness generally, but directly reduce the number of deaths from consumption

until the mortality from this cause is less in London than in any other large city. (It is, however, important to notice that the death-rate of young children from disease of the bowels has little, if at all, diminished. See Sir Richard Thorne's Harben Lectures.)

B. The prevention of infection of the lungs by the bacillus of tubercle depends chiefly on the rational treatment of the sputa of consumptive patients, or rather, for practical purposes, of the sputa of all those affected with cough and expectoration. The phlegm should never be deposited on the ground or on a handkerchief, where it can dry up; it should be kept moist until it can be destroyed by heat, and the vessel used to receive it should contain phenol or some other antiseptic solution.

C. The prevention of infection by tuberculous milk may be accomplished either by boiling all milk given as food to children or by inspection of dairies, so as to prevent tuberculous milch-cows being used.

D. The prevention of infection by meat can be secured by careful and thorough inspection of carcasses, or by diagnostic testing of cattle with tuberculin. This, the only undoubtedly useful application of the so called tuberculin, has the drawback that after the effect of the inoculation has passed off a tuberculous animal becomes immune to it for a time, and so may be passed as healthy. (It is said that cattle suspected of tubercle are thus rendered immune to the tubercular test before being sent over the French frontier.)

Though the question of the treatment of phthisis was only a supplementary part of the work of the Congress, Dr. Pye-Smith gives the following facts, which are, he says, "important for the people as well as their governors to be aware of":

a. That tuberculous disease of the bones and joints of the glands and skin and abdomen, though dangerous, is not incurable, and, by the modern methods of operative medicine, is in most cases successfully cured.

b. That tuberculosis of the lungs (phthisis, or consumption) is frequently cured, and probably more often now than formerly. (Curschmann, of Leipzig, fourth day of Congress.)

c. That there is no specific drug which has direct influence upon consumption, but that many, both old and new, have valuable effects upon its complications. (On the Action of the New Tuberculin, see Briger's paper, on the second day of Congress, and Dr. C. T. Williams in the R. Med. Ch. Trans. for the present year.)

d. That abundant food, particularly of a fatty nature, and a life in the open air, are no less valuable in the treatment than in the prevention of phthisis, and that the hospitals and asylums for providing these essentials, which are now numerous in Germany, and far from rare in England, Austria and Hungary, France and the United States, are of essential value. That the 'open-air treatment' has been long known and practiced in the United Kingdom was handsomely acknowledged by Professor Von Leyden (first day of Congress). Compare papers by Kaurin (Norway), Westhoven (Ludwigshaven), J. R. Walters (London), Desider Kuthy (Budapest), Schmidt (Switzerland), Dómene (Spain), fourth day.

e. That the influence of climate, altitude, temperature, and dryness of the air and soil, of travelling and of sea voyages has been very differently estimated at different periods, and that, while each is in various degrees important, popular opinion probably exaggerates their power. (Herman Weber, of London, fourth day of Congress.)

f. That the prospect of improved success in the treatment of tuberculosis in general, and of consumption in particular, by the advance of pathology and the progress of surgery and medicine, is a hopeful one, almost as hopeful as that of limiting the spread of the disease by preventive measures.

SCIENTIFIC NOTES AND NEWS.

Professor Simon Newcomb has been elected president of the Astronomical and Astrophysical Society of America, organized last week at the Yerkes Observatory, in succession to the Conferences of Astronomers and Astrophysicists which met last year at the Harvard College Observatory and the preceding year at Yerkes Observatory.

The delegates of the National Geographic Society to the Seventh International Geograph-

ical Congress, which will be held at Berlin from Thursday, September 28th, to Wednesday, October 4th, under the auspices of 'die Gesellschaft für Erdkunde zu Berlin,' are as follows: Dr. Alexander Graham Bell, President of the Society; Gen. A. W. Greely, U.S.A., also designated by President McKinley to represent the United States Government; Professor Willis L. Moore, Chief of the Weather Bureau; Hon. Andrew D. White, U. S. Ambassador to Germany; Miss Eliza Ruhamah Scidmore, Foreign Secretary of the Society; Mr. Marcus Baker, of the U. S. Geological Survey; Dr. L. A. Bauer, of the U. S. Coast and Geodetic Survey; and Professor Wm. M. Davis, of Harvard University.

The German government has sent Professor von Volkens, of the University of Berlin, to the Caroline Islands to investigate the soil and the flora.

Albert B. Prescott, professor of chemistry in the University of Michigan, was elected president of the American Pharmaceutical Association at its meeting last week at Put-in Bay, Ohio.

We regret to record the following deaths: Dr. Karl Bernhard Brühl, formerly professor of zootomy in the University of Vienna, on August 14th, aged 80 years; Professor Erhardt, formerly director of the Museum of Natural History at Coburg, aged 80 years, and Professor Oluf Rygh, who held the chair of archæology at Christiania.

Mr. O. G. Jones, instructor of Physics in the City of London School, has been killed by an Alpine accident on the Dent Blanche near Zermatt.

The British Association has this week begun its meeting at Dover. According to preliminary announcements, Professor Michael Foster, the President, will compare the condition of science in 1899 and 1799, and will dwell upon the intellectual influence of science and its value as mental training. He will also consider the benefits of international efforts. The addresses by the presidents before the Sections will be as follows: Mathematics and Physics, Professor J. H. Poynting, on the nature of law, explanation and hypothesis as used in physical science; Chemistry, Mr. Horace T. Brown, on the assimilation of carbon by the higher plants; Geology, Sir Archibald Geikie, on geological time; Zoology, Professor Adam Sedgwick, on variation in phenomena connected with reproduction and sex; Geography, Sir John Murray, on the floor of the ocean; Political Economy and Statistics, Mr. Henry Higgs, on the consumption of wealth; Mechanical Science, Sir H. W. White, on steam navigation at high speeds; Anthropology, Mr. C. S. Read, subject not announced; Physiology, Mr. J. M. Langley, on the motor nerves; Botany, Sir George King, on systematic botany in India. Professor Ch. Richet will give a lecture on nervous vibration, and Professor Fleming one on the centenary of the electric current. The usual lecture to working men will this year be omitted.

The systematic effort begun in June by the National Geographic Society toward the enlargement of its work by increasing its membership throughout the country is proving most successful. Within the last three months over 375 non-resident members have been enrolled, representing every state in the Union and different sections of Canada. The membership of the Society is now about 2,000.

The 18th Annual Congress of the Sanitary Institute of Great Britain opened at Southampton on August 29th with about 1,700 members in attendance. The president, Sir W. H. Preece, made the annual address, in which he discussed pure air, pure water, pure food, pure soil and pure dwellings.

The burning of the buildings of the Volta Centenary Exposition, at Como, will not, as we have already stated, prevent the holding of the electrical congress, which opens on the 18th inst. Professor Righi will open the congress with a commemorative address on Volta. As part of the proceedings there will be a discussion on electrical terminology.

The American Museum of Natural History, New York City, has now twenty-three representatives in the field engaged as follows: The Jesup expedition to the North Pacific making archæological and ethnological researches in British Columbia and Northeastern Siberia; the Jesup zoological expedition to the United

States of Columbia; the Constable expedition to the Northwest for large mammals; an expedition to New Mexico to study the cliff dwellings and the Pueblos; an expedition for the study of North American Indians in California and Arizona; a paleontological expedition to Wyoming; an expedition to Peru and Bolivia under Dr. Bandelier, and lastly local archæological work.

IT is reported that the explorer, Professor Wilhelm Joest, who died some time ago during an expedition among the South Sea islands, has left $75,000 to the Ethnological Museum in Berlin. The interest of that sum is to be used for getting new collections and assisting scientific expeditions.

NEWS has been received from the steamship, *Windward*, which has arrived at Newfoundland from North Greenland, and from the steamship *Diana*, which arrived at Cape Breton on the 12th. The two steamships met at Etah on August 12th, and under Lieutenant Peary's direction made arrangements for the winter and for the explorations in the spring. The *Windward* was ice-bound in Allman Bay about fifty miles north of Cape Sabine, from August 18, 1898, to August 2, 1899. During this period Lieutenant Peary made sledging journeys aggregating more than 1,500 miles, including a visit to Fort Conger, headquarters of the Greely expedition. The *Fram* was also at Etah at the same time as the other two steamships.

THERE will be a U. S. Civil Service examination on October 4th to fill the position of assistant physician in the Government Hospital for the insane. One man is wanted at a salary of $900, and one woman at a salary of $600.

THE new white star steamship *Oceanic* sailed from Liverpool for New York on the 6th inst., with 1,400 passengers. The steamship is the largest afloat, its tonnage being 17,000 and its length 704 feet.

EXPERIMENTS in wireless telegraphy are being made between the Blue Hill Observatory and Cambridge, the wires at the Blue Hill Observatory being attached to kites.

A COMPETITION has been held in Liverpool for motor vehicles invented for heavy traffic. Distances from 30 to 40 miles were traversed on two successive days, and six motors, all using steam, took part. The Steam Carriage and Wagon Company was given gold medals, both for vehicles having a minimum load of two tons, and for those having a minimum load of six and one-half tons.

IT is reported that an International Sanitary Commission will meet at Brussels during the present month to discuss measures for preventing the spreading of the plague in Europe.

WE learn from the *Botanical Gazette* that Mr. J. N. Rose, who was accompanied by Dr. Walter Hough, has just returned from a three months' trip through Mexico, bringing about nine hundred species of dried plants, many living plants and plant photographs. Besides rediscovering *Echmocactus Parryi*, he collected several other species lost or hitherto unknown to American herbaria. About 200 species were collected at type localities. Mr. Rose made a thorough study of the species of agave, especially those used in the manufacture of pulque and mescal.

THE special committee on Weights and Measures at the recent meeting of the American Pharmaceutical Association, submitted the following report:

No action has been taken during the past year, by the legislative branch of our Government in regard to the adoption of the Metric System of Weights and Measures.

The bill formerly before Congress, making the Metric System the legal system of weights and measures in the United States, is still in the hands of the Committee on Coinage, Weights and Measures.

Notwithstanding the inactivity of Congress on this question, we are pleased to report a healthy growth in the sentiment favoring the use of the Metric System both in medicine and for general usage.

In many of the reports made to the President by United States Consuls, the importance of the adoption of the Metric System by the United States for commercial purposes, is dwelt upon and strongly recommended. In a number of recent medical journals, editorials have been published advocating its adoption by the medical colleges.

While no definite statement can be made as to the probable action by the next Congress of the United States, or by the new Committee on Coinage, Weights and Measures yet to be appointed, it is hoped

by your committee that some definite advance can be made toward the adoption of the Metric System during the sessions of the Fifty-sixth Congress.

UNIVERSITY AND EDUCATIONAL NEWS.

THE plans for building the University of California, submitted by M. Bernard, of Paris, have received the first prize in the competition arranged by Mrs. Phoebe Hearst. The cost of the buildings is estimated at over $15,000,000. Contrary to the statements in the daily papers we understand that Mrs. Hearst has not as yet undertaken to defray the cost of any of the new buildings.

IN addition to $300,000 subscribed from various sources for an endowment of Brown University, made on condition that $2,000,000 be collected, Mr. John D. Rockefeller has offered to give $250,000 on condition that $1,000,000 be raised before commencement of next year.

ACCORDING to a dispatch in the daily papers Mr. S. F. Loubat, of New York, now residing at Paris, has given 300,000 Marks to the University of Berlin to endow a professorship 'for Americans,' which probably means for 'Americana,' a subject in which Mr. Loubat is much interested.

A CORRESPONDENT of the London *Times* sends the epitaph of the founder of Yale University from his tombstone in Wrexham Churchyard, North Wales, which is as follows:

Eliugh Yale, Esq., was buried the twenty-second of July in the year of our Lord MDCCXXI.

'Born in America, in Europe bred,
'In Africa travelled, in Asia wed,
'Where long he lived and thrived, in London dead.
'Much good, some ill, he did, so hope all's even,
'And that his soul through mercy's gone to Heaven.
'You that survive, and read this tale, take care
'For this most certain exit to prepare,
'Where blest in peace the action of the just
'Smell sweet, and blossom in the silent dust.'

IT was remarked in a recent number of SCIENCE that "the most disappointing aspect of university education seems to be the complete lack of medical students who take higher degrees." The observation appears to be enforced by the fact that three of the students who this year received the Ph.D. in psychology at Columbia University have been appointed to assistantships in the physiological laboratories of medical schools—Drs. G. V. N. Dearborn and S. I. Franz in the Harvard Medical School, and Dr. R. S. Woodworth in the University and Bellevue Hospital Medical College.

DAVID R. MAJOR, Ph.D. (Cornell), who was last year fellow in education at Teachers College, Columbia University, has been appointed acting professor of pedagogy in the University of Nebraska.

L. C. GLEN, Ph.D. (Johns Hopkins), has been appointed professor of geology at South Carolina College. F. A. Saunders, Ph. D (Johns Hopkins), has been appointed instructor in physics in Haverford College.

MR. EDGAR R. CUMMINGS, a recent graduate of Union College, has been appointed an instructor in geology in Indiana University. Mr. Cummings has published papers on the geology of the Mohawk Valley, N. Y., and is planning original work in the stratigraphical geology and paleontology of Indiana.

PROFESSOR W. S. MILLER, of the University of Wisconsin, has declined a call to the chair of anatomy and histology in the University of the State of Missouri.

DR. ALEXANDER MCADIE, of the San Francisco Weather Bureau, has been appointed honorary lecturer in meteorology in the University of California.

AT the University of North Carolina, J. E. Latta, B.Ph. (University of North Carolina), has been appointed instructor in physics, and Thomas Clarke, B.S. (University of Carolina, '96), Ph.D. (Brown University, '98), instructor in chemistry.

DR. ADOLF MIETHE, of Braunschweig, has been appointed professor of photo-chemistry in the Technical Institute at Berlin.

THE following have qualified as docents in German universities: Dr. Kauffman in physics at Göttingen; Dr. Henneberg in anatomy at Geessen, and Dr. Göttler in mathematics at Munich.

DR. OTTO KRIGAR-MENZEL, docent in physics in the University of Berlin, has been appointed to an associate professorship.

SCIENCE

FRIDAY, SEPTEMBER 22, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION.*

THE members of this Section will, I am sure, desire me to give expression to the gratification that we all feel in the realization of the scheme first proposed from this chair by Dr. Lodge, the scheme for the establishment of a national Physical Laboratory. It would be useless here to attempt to point out the importance of the step taken in the definite foundation of the Laboratory, for we all recognize that it was absolutely necessary for the due progress of physical research in this country. It is matter for congratulation that the initial guidance of the work of the Laboratory has been placed in such able hands.

While the investigation of nature is ever increasing our knowledge, and while each new discovery is a positive addition never again to be lost, the range of the investigation and the nature of the knowledge gained form the theme of endless discussion. And in this discussion, so different are the views of different schools of thought, that it might appear hopeless to look for general agreement, or to attempt to mark progress.

Nevertheless, I believe that in some directions there has been real progress,

* Given at the Dover meeting on September 14, 1899, by the President of the Section.

and that physicists, at least, are tending towards a general agreement as to the nature of the laws in which they embody their discoveries, of the explanations which they seek to give, and of the hypotheses they make in their search for explanations.

I propose to ask you to consider the terms of this agreement, and the form in which, as it appears to me, they should be drawn up.

The range of the physicist's study consists in the visible motions and other sensible changes of matter. The experiences with which he deals are the impressions on his senses, and his aim is to describe in the shortest possible way how his various senses have been, will be, or would be affected.

His method consists in finding out all likenesses, in classing together all similar events, and so giving an account as concise as possible of the motions and changes observed. His success in the search for likenesses and his striving after conciseness of description lead him to imagine such a constitution of things that likenesses exist even where they elude his observation, and he is thus enabled to simplify his classification on the assumption that the constitution thus imagined is a reality. He is enabled to predict on the assumption that the likenesses of the future will be the likenesses of the past.

His account of Nature, then, is, as it is often termed, a descriptive account.

Were there no similarities in events, our account of them could not rise above a mere directory, with each individual event entered up separately with its address. But the similarities observed enable us to class large numbers of events together, to give general descriptions, and indeed to make, instead of a directory, a readable book of science, with laws as the headings of the chapters.

These laws are, I believe, in all cases brief descriptions of observed similarities. By way of illustration let us take two or three examples.

The law of gravitation states that to each portion of matter we can assign a constant —its mass—such that there is an acceleration towards it of other matter proportional to that mass divided by the square of its distance away. Or all bodies resemble each other in having this acceleration towards each other.

Hooke's law for the case of a stretched wire states that each successive equal small load produces an equal stretch, or states that the behavior of the wire is similar for all equal small pulls.

Joule's law for the heat appearing when a current flows in a wire states that the rate of heat development is proportional to the square of the current multiplied by the resistance, or states that all the different cases resemble each other in having $H \div C^2Rt$ constant.

And, generally, when a law is expressed by an equation, that equation is a statement that two different sets of measurements are made, represented by the terms on the two sides of the equation, and that all the different cases resemble each other in that the two sets have the constant relation expressed by the equation. Accurate prediction is based on the assumption that when we have made the measurements on the one side of the equation we can tell the result of the measurements implied on the other side.

If this is a true account of the nature of physical laws, they have, we must confess, greatly fallen off in dignity. No long time ago they were quite commonly described as the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often tentative, often erroneous, of similarities which we believe we have observed.

The old conception of laws as self-sufficing governors of Nature was, no doubt, a

survival of a much older conception of the scope of physical science, a mode of regarding physical phenomena which has itself passed away.

I imagine that originally man looked on himself and the result of his action in the motions and changes which he produced in matter, as the one type in terms of which he should seek to describe all motions and changes. Knowing that his purpose and will were followed by motions and changes in the matter about him, he thought of similar purpose and will behind all the motions and changes which he observed, however they occurred; and he believed, too, that it was necessary to think thus in giving any consistent account of his observations. Taking this anthropomorphic—or, shall we say, psychical—view, the laws he formulated were not merely descriptions of similarities of behavior, but they were also expressions of fixed purpose and the resulting constancy of action. They were commands given to matter which it must obey.

The psychical method, the introduction of purpose and will, is still appropriate when we are concerned with living beings. Indeed, it is the only method which we attempt to follow when we are describing the motions of our fellow-creatures. No one seeks to describe the motions and actions of himself and of his fellow-men, and to classify them without any reference to the similarity of purpose when the actions are similar. But as the study of Nature progressed, it was found to be quite futile to bring in the ideas of purpose and will when merely describing and classifying the motions and changes of non-living matter. Purpose and will could be entirely left out of sight, and yet the observed motions and changes could be described, and predictions could be made as to future motions and changes. Limiting the aim of physical science to such description and prediction, it gradually became clear that the method was adequate for the purpose, and over the range of non-living matter, at least, the psychical yielded to the physical. Laws ceased to be commands analogous to legal enactments, and became mere descriptions. But during the passage from one position to the other, by a confusion of thought which may appear strange to us now that we have finished the journey, though no doubt it was inevitable, the purpose and will of which the laws had been the expression were put into the laws themselves; they were personified and made to will and act.

Even now these early stages in the history of thought can be traced by survivals in our language, survivals due to the ascription of moral qualities to matter. Thus gases are still sometimes said to obey or to disobey Boyle's law as if it were an enactment for their guidance, and as if it set forth an ideal, the perfect gas, for their imitation. We still hear language which seems to imply that real gases are wanting in perfection, in that they fail to observe the exact letter of the law. I suppose on this view we should have to say that hydrogen is nearest to perfection; but then we should have to regard it as righteous overmuch, a sort of Pharisee among gases which overshoots the mark in its endeavor to obey the law. Oxygen and nitrogen we may regard as good enough in the affairs of everyday life. But carbon dioxide and chlorine and the like are poor sinners which yield to temptation and liquefy whenever circumstances press at all hardly on them.

There is a similar ascription of moral qualities when we judge bodies according to their fulfillment of the purpose for which we use them, when we describe them as good or bad radiators, good or bad insulators, as if it were a duty on their part to radiate well, or insulate well, and as if there were failures on the part of Nature to come up to the proper standard.

These are of course mere trivialities, but

the reaction of language on thought is so subtle and far-reaching that, risking the accusation of pedantry, I would urge the abolition of all such picturesque terms. In our quantitative estimates let us be content with 'high' or 'low,' 'great' or 'small,' and let us remember that there is no such thing as a failure to obey a physical law. A broken law is merely a false description.

Concurrently with the change in our conception of physical law has come a change in our conception of physical explanation. We have not to go very far back to find such a statement as this—that we have explained anything when we know the cause of it, or when we have found out the reason why—a statement which is only appropriate on the psychical view. Without entering into any discussion of the meaning of cause, we can at least assert that that meaning will only have true content when it is concerned with purpose and will. On the purely physical or descriptive view, the idea of cause is quite out of place. In description we are solely concerned with the 'how' of things, and their 'why' we purposely leave out of account. We explain an event not when we know 'why' it happened, but when we show 'how' it is like something else happening elsewhere or otherwhen—when, in fact, we can include it as a case described by some law already set forth. In explanation, we do not account *for* the the event, but we improve our account *of* it by likening it to what we already knew.

For instance, Newton explained the falling of a stone when he showed that its acceleration towards the earth was similar to and could be expressed by the same law as the acceleration of the moon towards the earth.

He explained the air disturbance we call 'sound' when he showed that the motions and forces in the pressure waves were like motions and forces already studied.

Franklin explained lightning when and so far as he showed that it was similar in its behavior to other electric discharges.

Here I do not fear any accusation of pedantry in joining those who urge that we should adapt our language to the modern view. It would be a very real gain, a great assistance to clear thinking, if we could entirely abolish the word 'cause' in physical description, cease to say 'why' things happen unless we wish to signify an antecedent purpose, and be content to own that our laws are but expressions of 'how' they occur.

The aim of explanation, then, is to reduce the number of laws as far as possible, by showing that laws, at first separated, may be merged in one; to reduce the number of chapters in the book of science by showing that some are truly mere sub-sections of chapters already written.

To take an old but never-worn-out metaphor, the physicist is examining the garment of Nature, learning of how many, or rather of how few different kinds of thread it is woven, finding how each separate thread enters into the pattern, and seeking from the pattern woven in the past to know the pattern yet to come.

How many different kinds of thread does Nature use?

So far, we have recognized some eight or nine, the number of different forms of energy which we are still obliged to count as distinct. But this distinction we cannot believe to be real. The relations between the different forms of energy, and the fixed rate of exchange when one form gives place to another, encourage us to suppose that if we could only sharpen our senses, or change our point of view, we could effect a still further reduction. We stand in front of Nature's loom as we we watch the weaving of the garment; while we follow a particular thread in the pattern it suddenly disappears, and a thread of another color takes its place. Is this a new thread, or is

it merely the old thread turned round and presenting a new face to us? We can do little more than guess. We cannot get to the other side of the pattern, and our minutest watching will not tell us all the working of the loom.

Leaving the metaphor, were we true physicists, and physicists alone, we should, I suppose, be content to describe merely what we observe in the changes of energy. We should say, for instance, that so much kinetic energy ceases, and that so much heat appears, or that so much light comes to a surface, and that so much chemical energy takes its place. But we have to take ourselves as we are, and reckon with the fact that though our material is physical, we ourselves are psychical. And, as a mere matter of fact, we are not content with such discontinuous descriptions. We dislike the discontinuity and we think of an underlying identity. We think of the heat as being that which a moment before was energy of a visible motion, we think of the light as changing its form alone and becoming itself the chemical energy. Then to our passive dislike to discontinuity we join our active desire to form a mental picture of what may be going on, a picture like something which we already know. Coming on these discontinuities our ordinary method of explanation fails, for they are not obviously like those series of events in which we can trace every step. We then imagine a constitution of matter and modifications of it corresponding to the different kinds of energy, such that the discontinuities vanish, and such that we can picture one form of energy passing into another and yet keeping the same in kind throughout. We are no longer content to describe what we actually see or feel, but we describe what we imagine we should see or feel if our senses were on quite another scale of magnitude and sensibility. We cease to be physicists of the real and become physicists of the ideal.

To form such mental pictures we naturally choose the sense which makes such pictures most definite, the sense of sight, and think of a constitution of matter which shall enable us to explain all the various changes in terms of visible motions and accelerations. We imagine a mechanical constitution of the universe.

We are encouraged in this attempt by the fact that the relations in this mechanical conception can be so exactly stated, that the equations of motion are so very definite. We have, too, examples of mechanical systems, of which we can give accounts far exceeding in accuracy the accounts of other physical systems. Compare, for instance, the accuracy with which we can describe and foretell the path of a planet with our ignorance of the movements of the atmosphere as dependent on the heat of the sun. The planet keeps to the astronomer's time table, but the wind still bloweth almost where it listeth.

The only foundation which has yet been imagined for this mechanical explanation—if we may use 'explanation' to denote the likening of our imaginings to that which we actually observe—is the atomic and molecular hypothesis of matter. This hypothesis arose so early in the history of science that we are almost tempted to suppose that it is a necessity of thought, and that it has a warrant of some higher order than any other hypothesis which could be imagined. But I suspect that if we could trace its early development we should find that it arose in an attempt to explain the phenomena of expansion and contraction, evaporation and solution. Were matter a continuum we should have to admit all these as simple facts, inexplicable in that they are like nothing else. But imagine matter to consist of a crowd of separate particles with interspaces. Contraction and expansion are then merely a drawing in and a widening out of the crowd. Solu-

tion is merely the mingling of two crowds, and evaporation merely a dispersal from the outskirts. The most evident properties of matter are then similar to what may be observed in any public meeting.

For ages the molecular hypothesis hardly went further than this. The first step onward was the ascription of vibratory motion to the atoms to explain heat. Then definite qualities were ascribed, definite mutual forces were called into play to explain elasticity and other properties or qualities of matter. But I imagine its first really great achievement was its success in explaining the law of combining proportions, and next to that we should put its success in explaining many of the properties of gases.

While light was regarded as corpuscular —in fact molecular, and while direct action at a distance presented no difficulty, the molecular hypothesis served as the one foundation for the mechanical representation of phenomena. But when it was shown that infinitely the best account of the phenomena of light could be given on the supposition that it consisted of waves, something was needed, as Lord Salisbury has said, to wave, both in the interstellar and in the intermolecular spaces. So the hypothesis of an ether was developed, a necessary complement of that form of the molecular hypothesis in which matter consists of discrete particles with matter-free intervening spaces.

Then Faraday's discovery of the influence of the dielectric medium in electric actions led to the general abandonment of the idea of action at a distance, and the ether was called in to aid matter in the explanation of electric and magnetic phenomena. The discovery that the velocity of electro-magnetic waves is the same as that of light waves is at least circumstantial evidence that the same medium transmits both.

I suppose we all hope that some time we shall succeed in attributing to this medium such further qualities that it will be able to enlarge its scope and take in the work of gravitation.

The mechanical hypothesis has not always taken this dualistic form of material atoms and molecules, floating in a quite distinct ether. I think we may regard Boscovich's theory of point-centers surrounded by infinitely extending atmospheres of force as really an attempt to get rid of the dualism, and Faraday's theory of point-centers with radiating lines of force is only Boscovich's theory in another form. But Lord Kelvin's vortex-atom theory gives us a simplification more easily thought of. Here all space is filled with continuous fluid —shall we say a fluid ether—and the atoms are mere loci of a particular type of motion of this frictionless fluid. The sole differences in the atoms are differences of position and motion. Where there are whirls, we call the fluid matter; where there are no whirls we call it ether. All energy is energy of motion. Our visible kinetic energy, $MV^2/2$, is energy in and around the central whirls; our visible energy of position, our potential energy, is energy of motion in the outlying regions.

A similar simplification is given by Dr. Larmor's hypothesis, in which, again, all space is filled with continuous substance all of one kind, but this time solid rather than fluid. The atoms are loci of strain instead of whirls, and the ether is that which is strained.

So, as we watch the weaving of the garment of Nature, we resolve it in imagination into threads of ether spangled over with beads of matter. We look still closer, and the beads of matter vanish; they are mere knots and loops in the threads of ether.

The question now faces us—How are we to regard these hypotheses as to the consti-

tution of matter and the connecting ether? How are we to look upon the explanations they afford? Are we to put atoms and ether on an equal footing with the phenomena observed by our senses, as truths to be investigated for their own sake? Or are they mere tools in the search for truth, liable to be worn out or superseded?

That matter is grained in structure is hardly more than the expression of the fact that in very thin layers it ceases to behave as in thicker layers. But when we pass on from this general statement and give definite form to the granules or assume definite qualities to the intergranular cement, we are dealing with pure hypotheses.

It is hardly possible to think that we shall ever see an atom or handle the ether. We make no attempt whatever to render them evident to the senses. We connect observed conditions and changes in gross visible matter by invisible molecular and ethereal machinery. The changes at each end of the machinery of which we seek to give an account are in gross matter, and this gross matter is our only instrument of detection, and we never receive direct sense impressions of the imagined atoms or the intervening ether. To a strictly descriptive physicist their only use and interest would lie in their service in prediction of the changes which are to take place in gross matter.

It appears quite possible that various types of machinery might be devised to produce the known effects. The type we have adopted is undergoing constant minor changes, as new discoveries suggest new arrangements of the parts. Is it utterly beyond possibility that the type itself should change?

The special molecular and ethereal machinery which we have designed, and which we now generally use, has been designed because our most highly developed sense is our sense of sight. Were we otherwise, had we a sense more delicate than sight, one affording us material for more definite mental presentation, we might quite possibly have constructed very different hypotheses. Though, as we are, we cannot conceive any higher type than that founded on the sense of sight, we can imagine a lower type, and by way of illustration of the point let us take the sense of which my predecessor spoke last year—the sense of smell. In us it is very undeveloped. But let us image a being in whom it is highly cultivated, say, a very intellectual and very hypothetical dog. Let us suppose that he tries to frame an hypothesis as to light. Having found that his sense of smell is excited by surface exhalations, will he not naturally make and be content with a corpuscular theory of light? When he has discovered the facts of dispersion, will he not think of the different colors as different kinds of smell—insensible, perhaps, to him, but sensible to a still more highly gifted, still more hypothetical dog?

Of course, with our superior intellect and sensibility, we can see where his hypothesis would break down; but unless we are to assume that we have reached finality in sense development, the illustration, grotesque as it may be, will serve to show that our hypotheses are in terms of ourselves rather than in terms of Nature itself, they are ejective rather than objective, and so they are to be regarded as instruments, tools, apparatus only to aid us in the search for truth.

To use an old analogy—and here we can hardly go except upon analogy—while the building of Nature is growing spontaneously from within, the model of it, which we seek to construct in our descriptive science, can only be constructed by means of scaffolding from without, a scaffolding of hypotheses. While in the real building all is continuous, in our model there are detached parts which must be connected with the rest by tem-

porary ladders and passages, or which must be supported till we can see how to fill in the understructure. To give the hypotheses equal validity with facts is to confuse the temporary scaffolding with the building itself.

But even if we take this view of the temporary nature of our molecular and ethereal imaginings, it does not lessen their value, their necessity to us.

It is merely a true description of ourselves to say that we must believe in the continuity of physical processes, and that we must attempt to form mental pictures of those processes, the details of which elude our observation. For such pictures we must frame hypotheses, and we have to use the best material at command in framing them. At present there is only one fundamental hypothesis—the molecular and ethereal hypothesis—in some such form as is generally accepted.

Even if we take the position that the form of the hypothesis may change as our knowledge extends, that we may be able to devise new machinery—nay, even that we may be able to design some quite new type to bring about the same ends—that does not appear to me to lessen the present value of the hypothesis. We can recognize to the full how well it enables us to group together large masses of facts which, without it, would be scattered apart, how it serves to give working explanations, and continually enables investigators to think out new questions for research. We can recognize that it is the symbolical form in which much actual knowledge is cast. We might almost as well quarrel with the use of the letters of the alphabet, inasmuch as they are not the sounds themselves, but mere arbitrary symbols of the sounds.

In this country there is no need for any defence of the use of the molecular hypothesis. But abroad the movement from the position in which hypothesis is confounded with observed truth has carried many through the position of equilibrium equally far on the other side, and a party has been formed which totally abstains from molecules as a protest against immoderate indulgence in their use. Time will show whether these protesters can do without any hypothesis, whether they can build without scaffolding or ladders. I fear that it is only an attempt to build from balloons.

But the protest will have value if it will put us on our guard against using molecules and the ether everywhere and everywhen. There is, I think, some danger that we may get so accustomed to picturing everything in terms of these hypotheses that we may come to suppose that we may have no firm basis for the facts of observation until we have given a molecular account of them, that a molecular basis is a firmer foundation than direct experience.

Let me illustrate this kind of danger. The phenomena of capillarity can, for the most part, be explained on the assumption of a liquid surface tension. But if the subject is treated merely from this point of view it stands alone—it is a portion of the building of science hanging in the air. The molecular hypothesis then comes in to give some explanation of the surface tension, gives, as it were, a supporting understructure connecting capillarity with other classes of phenomena. But here, I think, the hypothesis should stop, and such phenomena as can be explained by the surface tension should be so explained without reference to molecules. They should not be brought in again till the surface-tension explanation fails. It is necessary to bear in mind what part is scaffolding, and what is the building itself, already firm and complete.

Or, as another illustration, take the Second Law of Thermodynamics. I suspect that it is sometimes supposed that a molecular theory from which the Second Law

could be deduced would be a better basis for it than the direct experience on which it was founded by Clausius and Kelvin or, that the mere imagining of a Maxwell's sorting demon has already disproved the universality of the law; whereas he is a mere hypothesis grafted on a hypothesis, and nothing corresponding to his action has yet been found.

There is more serious danger of confusion of hypothesis with fact in the use of the ether; more risk of failure to see what is accomplished by its aid. In giving an account of light, for instance, the right course, it appears to me, is to describe the phenomena and lay down the laws under which they are grouped, leaving it an open question what it is that waves, until the phenomena oblige us to introduce something more than matter, until we see what properties we must assign to the ether, properties not possessed by matter, in order that it may be competent to afford the explanations we seek. We should then realize more clearly that it is the constitution of matter which we have imagined, the hypothesis of discrete particles, which obliges us to assume an intervening medium to carry on the disturbance from particle to particle. But the vortex-atom hypothesis and Dr. Larmor's strain-atom hypothesis both seem to indicate that we are moving in the direction of the abolition of the distinction between matter and ether, that we shall come to regard the luminiferous medium, not as an attenuated substance here and there encumbered with detached blocks—the molecules of matter—but as something which in certain places exhibits modifications which we term matter. Or starting rather from matter, we may come to think of matter as no longer consisting of separated granules, but as a continuum with properties grouped round the centers, which we regard as atoms or molecules.

Perhaps I may illustrate the danger in the use of the conception of the ether by considering the common way of describing the electro-magnetic waves, which are all about us here, as ether waves. Now in all cases with which we are acquainted, these waves start from matter; their energy before starting was, as far as we can guess, energy of the matter between the different parts of the source, and they manifest themselves in the receiver as energy of matter. As they travel through the air, I believe that it is quite possible that the electric energy can be expressed in terms of the molecules of air in their path, that they are effecting atomic separations as they go. If so, then the air is quite as much concerned in their propagation as the ether between its molecules. In any case, to term them ether waves is to prejudge the question before we have sufficient evidence.

Unless we bear in mind the hypothetical character of our mechanical conception of things, we may run some risk of another danger—the danger of supposing that we have something more real in mechanical than in other measurements. For instance, there is some risk that the work measure of specific heat should be regarded as more fundamental than the heat measure, in that heat is truly a 'mode of motion.' On the molecular hypothesis, heat is no doubt a mixture of kinetic energy and potential energy of the molecules and their constituents, and may even be entirely kinetic energy; and we may conceivably in the future make the hypothesis so definite that, when we heat a gramme of water 1°, we can assign such fraction of an erg to each atom. But look how much pure hypothesis is here. The real superiority of the work measure of specific heat lies in the fact that it is independent of any particular substance, and there is nothing whatever hypothetical about it.*

*This risk of imagining one particular kind of

Another illustration of the illegitimate use of our hypothesis, as it appears to me, is in the attempt to find in the ether a fixed datum for the measurement of material velocities and accelerations, a something in which we can draw our coördinate axes so that they will never turn or bend. But this is as if, discontented with the movement of the earth's pole, we should seek to find our zero lines of latitude and longitude in the Atlantic Ocean. Leaving out of sight the possibility of ethereal currents which we cannot detect, and the motions due to every ray of light which traverses space, we could only fix positions and directions in the ether by buoying them with matter. We know nothing of the ether, except by its effects on matter, and, after all, it would be the material buoys which would fix the positions and not the ether in which they float.

The discussion of the physical method, with its descriptive laws and explanations, and its hypothetical extension of description, leads us on to the consideration of the limitation of its range. The method was developed in the study of matter which we describe as non-living, and with non-living matter the method has sufficed for the particular purposes of the physicist. Of course only a little corner of the universe has been explored, but in the study of non-living matter we have come to no impassable gulfs, no chasms across which we cannot throw bridges of hypothesis. Does the method equally suffice when it is applied to living matter? Can we give a purely physical account of such matter, likening its motions and changes to other motions and changes already observed, and so explaining them? Can we group them in laws which will enable us to predict future conditions and positions?—The ancient question never answered, but never ceasing to press for an answer.

Having faith in our descriptive method, let us use it to describe our real attitude on the question. Do we, or do we not, as a matter of fact, make any attempt to apply the physical method to describe and explain those motions of matter which on the psychical view we term voluntary?

Any commonplace example, and the more commonplace the more it is to the point, will at once tell us our practice, whatever may be our theory. For instance, a steamer is going across the Channel. We can give a fairly good physical account of the motion of the steamer. We can describe how the energy stored in the coal passes out through the boiler into the machinery, and how it is ultimately absorbed by the sea. And the machinery once started, we can give an account of the actions and reactions between its various parts and the water, and if only the crew will not interfere, we can predict with some approach to correctness how the vessel will run. All these processes can be likened to processes already studied—perhaps on another scale—in our laboratories, and from the similarities prediction is possible. But now think of a passenger on board who has received an invitation to take the journey. It is simply a matter of

measure more real than another, more in accordance with the truth of things, may be further illustrated by the common idea that mass-acceleration is the only way to measure a force. We stand apart from our mechanical system and watch the motions and the accelerations of the various parts, and we find that mass-accelerations have a certain significance in our system. If we keep ourselves outside the system and only use our sense of sight, then mass-acceleration is the only way of describing that behavior of one body in the presence of others which we term force on it. But if we go about in the system and pull and push bodies, we find that there is another conception of force, in which another sense than sight is concerned —another mode of measurement much more ancient and still far more extensively used—the measurement by weight supported. Each method has its own range; each is fundamental in that range. It is one of the great practical problems in physics to make the pendulum give us the exact ratio of the units in the two systems.

fact that we make no attempt at a complete physical account and explanation of those actions which he takes to accomplish his purpose. We trace no lines of induction in the ether connecting him with his friends across the Channel, we seek no law of force under which he moves. In practice the strictest physicist abandons the physical view, and replaces it by the psychical. He admits the study of purpose as well as the study of motion.

He has to admit that here his physical method of prediction fails. In physical observations one set of measurements may lead to the prediction of the results of another set of measurements. The equations expressing the laws imply different observations with some definite relation between their results, and if we know one set of observations and that definite relation we can predict the result of the other set. But if we take the psychical view of actions, we can only measure the actions. We have no independent means of studying and measuring the motions which preceded the actions, we can only estimate their value by the consequent actions. If we formed equations they would be mere identities with the same terms on either side.

The consistent and persistent physicist, finding the door closed against him, finding that he has hardly a sphere of influence left to him in the psychical region, seeks to apply his methods in another way, by assuming that if he knew all about the molecular positions and motions in the living matter, then the ordinary physical laws could be applied, and the physical conditions at any future time could be predicted. He would say, I suppose, with regard to the Channel passenger, that it is absurd to begin with the most complicated mechanism, and seek to give a physical account of that. He would urge that we should take some lower form of life where the structure and motions are simpler, and apply the physical methods to that.

Well, then, let us look for the physical explanation of any motion which we are entitled from its likeness to our own action to call a voluntary motion. Must we not own that even the very beginning of such explanation is as yet non-existent? It appears to me that the assumption that our methods do apply, and that purely physical explanation will suffice to predict all motions and changes, voluntary and involuntary, is at present simply a gigantic extrapolation, which we should unhesitatingly reject if it were merely a case of ordinary physical investigation. The physicist when thus extending his range is ceasing to be a physicist, ceasing to be content with his descriptive methods in his intense desire to show that he is a physicist throughout.

Of course we may describe the motions and changes of any type of matter after the event, and in a purely physical manner. And as Professor Ward has suggested, in a most important contribution to this subject which he has made in his recently published Gifford Lectures,* where ordinary physical explanations fail to give an account of the motions, we might imagine some structure in the ether, and such stresses between the ether and matter that our physical explanations should still hold. But, as Professor Ward says, such ethereal constructions would present no warrant for their reality or consistency. Indeed they would be mere images in the surface of things to account for what goes on in front of the surface, and would have no more reality than the images of objects in a glass.

If we have full confidence in the descriptive method, as applied to living and non-living matter, it appears to me that up to the present it teaches us that while in non-living matter we can always find similarities, that, while each event is like other events, actual or imagined, in a living being there

* 'Naturalism and Agnosticism,' *The Gifford Lectures*, 1896–98, Vol II., p. 71.

are always dissimilarities. Taking the psychical view—the only view which we really do at present take—in the living being there is always some individuality, something different from any other living being, and full prediction in the physical sense, and by physical methods is impossible. If this be true, the loom of Nature is weaving a pattern with no mere geometrical design. The threads of life, coming in we know not where, now twining together, now dividing, are weaving patterns of their own, ever increasing in intricacy, ever gaining in beauty.

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*THE WORK OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.**

Prior to the year 1800 little was known of the properties of the materials of construction. Gallileo had shown in 1638 that the strength of a rectangular beam varied with the square of its depth; Hooke in 1678 had announced the law that the stretch of a spring was proportional to the stress upon it; various authors had discussed the forms of beams of uniform strength, and Euler, in 1744, had enunciated his formula for the resistance of columns under compression. Theory was far in advance of practice, for experiments had been so few and so imperfect that the elastic limit was scarcely recognized.

During the years from 1800 to 1850 great progress was made in the theory of elasticity, and a slow growth took place in knowledge of the properties of materials under stress. The introduction of railways and the consequent necessity of providing a firm roadbed and safe bridge structures gave a powerful stimulus to the investigation of metals, in order that ample security might be afforded with the greatest degree of economy. The methods of testing were, however, so imperfect that progress was slow, and, with the exception of the classic researches of Hodgskinson, the work of this period was mostly of value as a preparation for that of the future.

After 1850 large testing machines for special purposes began to be built, elongation and ductility began to be carefully studied, and soon after 1870, it was recognized by many manufacturers that physical tests of metals were imperatively necessary in order to secure uniformity of product. As these tests were multiplied and the records subjected to investigation, the knowledge was gained that the strength of a specimen depended upon its size and proportions and also upon the manner in which the load was applied. The term elastic limit assumed a new significance when it became recognized that it could be defined and measured in different ways. In short, it was found that tests of materials must be made in a similar manner in order to render the results comparable. This idea, although long recognized, has proved a difficult one to realize. It has been discussed by many engineering societies, some of which have attempted to formulate standard methods. Finally the International Association for Testing Materials was formed in order to study the whole subject and endeavor to arrive at conclusions that should be authoritative.

In 1882, through the influence of John Bauschinger, a number of German experimenters met at Munich and discussed the question as to how uniformity in the methods of testing materials could be promoted. As a result of this meeting, formal conferences were held at Dresden in 1884, at Berlin in 1886, at Munich in 1888, and at Vienna in 1893, delegates from other European countries being often present. The reports of the proceedings of these conferences, published in Bauschinger's *Mittheilungen*, attracted wide attention, and the

* An address by the Chairman of the American Section of the Association, at the second annual meeting held in Pittsburg, Pa., August 15-16, 1899.

great value and importance of the discussions became universally recognized in engineering circles. In short, the movement assumed an international character.

In 1890, as a result of the International Congresses of Engineering, held at Paris, in the preceding year, the French government appointed a commission to formulate standard methods for testing the materials of construction. Its report, published in 1894, in four large volumes, is one of the most valuable contributions to the subject, but from the first it was recognized that ultimate conclusions could not be determined by a commission of one nationality, and accordingly, since 1895, the French government has given hearty support to the work of the International Association.

In 1895, as a result of the four preceding conferences, the fifth conference met at Zurich, all European countries, except Turkey, being represented. The United States Government was represented by an army officer, and the American Society of Mechanical Engineers by a delegate. At this Congress the International Association for Testing Materials was formally organized, its object being, as stated in its statutes, "the development and unification of standard methods of testing for the determination of the properties of the materials of construction, and of other materials, and also the perfection of apparatus for that purpose." This meeting at Zurich hence assumed an importance far greater than any preceding conference, and it may be called the first Congress of the International Association.

At the Vienna convention of 1893 there had been appointed twenty committees on technical subjects, and reports from many of these were presented at the Zurich Congress of 1895. These reports were published in the French and German languages in the official organ of the Association called *Baumaterialienkunde*, the first number of which appeared in July, 1896. The work of some of these committees was continued, other subjects were proposed for future consideration, and a council was organized to transact the business of the International Association in the intervals between the Congresses.

In 1897 the second Congress of the International Association was held at Stockholm, there being present 361 members representing 18 countries. The United States Government was represented by an army officer and a navy officer, and the American Society of Mechanical Engineers by a delegate. The Congress continued in session for three days, reports of committees were presented, papers read and discussed, and plans outlined for future work. It was resolved that the next Congress should be held in Paris in the summer of 1900, and the Council was authorized to appoint technical committees to make reports at that time on special problems relating to the objects of the Association.

At a meeting of the International Council held early in 1898, appointments were made of chairmen of 21 committees on technical problems, and the number of members on each committee from each country was assigned. It was also recommended, in order to expedite the appointment and work of these committees, that the members in each country should meet and form a national section of the International Association. In compliance with this recommendation a number of the American members met on June 15, 1898, and organized an American Section, whose first annual meeting was held at Philadelphia on August 27, 1898, and whose second annual meeting I now have the honor to address.

The membership of the International Association numbered 493 in 1895; 953 in 1896; 1,169 in 1897; 1,488 in 1898, and is now probably about 2,000. Germany takes the lead in regard to number of members, it

having 387 in 1898, while Russia had 315, Austria 158, England 83, Switzerland 83, United States 68, Sweden 68, France 66, Holland 48, Norway 42, Denmark 39, Spain 36, Italy 35, and 60 from nine other countries. With regard to the American membership, it may be noted that it numbered 6 in 1895; 25 in 1896; 60 in 1897; 68 in 1898, prior to the organization of the American Section; 106 in February, 1899, and that it is now nearly or quite 125.

There are two peculiarities regarding membership in this Association that deserve notice. First, there is no nomination or election of members, but any person desiring to be a member may do so on signing a statement that he assumes membership and will be governed by the laws of the Association; in so doing he further assumes the obligation, stated in Art. 5, of the statutes, that he will advance its interests to the best of his ability. Membership is hence a voluntary act assumed by an individual in order to promote the knowledge of the properties of materials and to endeavor to secure uniformity in methods of testing them. Withdrawal from membership may be made at any time by mere announcement to the proper officer of the Association.

The second noteworthy feature regarding membership is that it may be assumed by a corporation or society as well as by a person. For example, in the list of members of the American Section, published in February last, will be found the Franklin Institute, the American Society of Mechanical Engineers, the American Foundrymen's Association, and five local engineering clubs, as also several steel companies, engineering journals, and firms engaged in inspecting and testing. In Europe this feature is carried much further, the membership of the German Section including the bureau of public works of several cities, provinces and states, the police bureau of Berlin, the Prussian war department and the boards of direction of numerous railways, as also a large number of manufacturing corporations and engineering societies. Under this arrangement it is possible for a corporation to exert a greater influence than through the indirect individual membership of its president or superintendent, both manufacturers and consumers can make their wishes more directly known, and thus differences in regard to methods of inspection and testing can be more quickly harmonized than under the usual plan of strict individual membership. However, fully three-fourths of the total members are individuals, and these include engineers in all branches, architects, chemists, professors of mechanics and engineering, and superintendents and foremen of works.

At the Zurich Congress the dues of members were fixed at $1.00 per year, and while no change was made at the Stockholm Congress, the Council recommended early in 1898, in view of the heavy expenses, that each member should pay $1.50 per year. Accordingly, at the first annual meeting of this Section, when our present by-laws were adopted, the provision was inserted that each member should pay $2.50 per year, of which $1.50 should be transmitted to the International Association and the remainder be used to defray the expenses of the American Section. This by-law went into effect on January 1, 1899, and accordingly no dues were collected by this Section for the year 1898, the $1.50 payable for that year being forwarded to the International Council directly by each member or through the American member of that Council. During the present year dues have been paid directly to our secretary, and his report, together with that of our treasurer, will be laid before this meeting.

The dues of $1.50 per year per member, transmitted to the International Council,

are used by it in issuing its publications and in assisting its committees in defraying a part of the expenses of their special investigations. In addition to this income a number of societies and bureaus have agreed to make extra annual contributions, the Prussian War Department heading the list with $125, and 21 others giving smaller sums, so that for the year 1898 the amount derived from these sources was about $400. Although official information is not at hand, it is safe to say that the total income of the International Association for the year 1898 did not exceed $2,000, which is certainly a small sum with which to issue its publications and carry on the work of 21 committees.

The International Association has issued yearly, since 1895, a list of members, and also abstracts of the proceedings of the Congresses of 1895 and 1897. These, together with a few circulars of information, constitute all the publications that it has been able to furnish free to its members. The detailed proceedings of the Congresses have been printed in the journal *Baumaterialienkunde* published in the French and German languages, at Stuttgart, which has been furnished to members at $2.50 per year, the regular subscription price being $3.50. It will be seen, therefore, that an American member who desires to be fully informed regarding the work of the Association must necessarily subscribe to this Journal, and by so doing his dues become really $5 per year. It should further be stated that arrangements will probably be made so that the official announcements of the International Council and the proceedings of future Congresses will be printed in this Journal in the English language, as well as in German and French.

The American Section, as already stated, had no income during 1898, and the report of our Treasurer shows that during the present year the amount available for expenses has been about $120. On February 18, a pamphlet of twenty-six pages was issued containing a list of officers of the International Association and its committees and a list of the American members, together with the statutes, by-laws and some historical information. In April a bulletin was issued giving abstracts of the proceedings of the first annual meeting and of the meetings of the executive committee, and in July a second bulletin was issued containing the preliminary programme for this meeting. It is hoped that the condition of our treasury may permit these bulletins to be continued, and that one may be issued containing the proceedings of this meeting.

The technical questions proposed for discussion at the Paris Congress of 1900 are nineteen in number. The organization of the international committees which are to consider these topics is now complete, and preliminary reports from the American members of several of them are to be presented and discussed at this meeting. Probably the most important of these subjects is that of standard international specifications for testing and inspecting iron and steel; this committee originally consisted of about forty members, of which five were assigned to this country, but under authority to increase its numbers the American sub-committee has been increased to twenty-one, has held several meetings, collected specifications and will present a preliminary report of much interest. It is also expected that the American members of five other international committees on iron and steel will report progress in their organization and work. As the national sub-committees are now in full correspondence with the international chairmen, it is expected that the final reports which are to be presented for discussion at the Paris Congress will prove of great interest and value.

Of the nineteen problems to be considered by the nineteen international committees,

six are on iron and steel, one on stone and slate, eight on cements and mortars, one on tile pipes, one on paints, one on lubricants, and one on the dry rot of wood. The fact that there are eight committees on cements and mortars and only six on iron and steel may seem abnormal, but it should be remembered that in the testing of hydraulic cement the personal equation of the observer enters to a far greater degree than in the case of metals, and that its rapidly increasing use demands the immediate perfection of methods which will render comparable the work of different laboratories. At the session to-morrow morning preliminary reports from some of our sub-committees on these questions will be presented.

While the main object of the Association is to establish standard rules for testing, it is recognized that this cannot be done until a thorough knowledge is obtained of the properties of materials under varying conditions. Accordingly the work of some of the committees is to collect and digest the information now on record, or to make scientific investigations that will render present knowledge more complete and definite. Thus, there is a committee on the properties of steel at abnormally low temperatures, one on the relation of the chemical composition of stone to its weathering qualities, one to digest the work of previous conferences and conventions on the adhesion of hydraulic cement, one on the causes of the abnormal behavior of cements as to time of setting, and one on the protection of wood against the action of dry rot. Some of these subjects have already been discussed at the Congresses of Zurich and Stockholm, and accordingly the reports to be presented to the Paris Congress should contain positive additions to present knowledge.

At the annual meeting of this Section, held last year, the desire was expressed to discuss the subject of impact tests, and a special committee was appointed whose report will be presented at this meeting. Later, other members requested that other problems should be taken up by the Section, and accordingly three other American committees have been organized on special problems connected with the manufacture of iron and steel. While these committees have no connection with the international ones, it is believed that their work will add to the interest of our annual meetings, and further the general objects of the Association.

There are advantages and disadvantages in doing technical work by committees. One advantage accrues through the harmonization of the different views held by individuals, whereby non-essentials are rejected and only fundamental methods retained. One of the disadvantages is that this process of harmonizing views takes time, causing reports to be long delayed, particularly with international committees. Some technical societies appoint committees with great reluctance, fearing that their reports may be regarded as official action. In the case of our international organization, no such fear is felt, and the report of a committee is to be considered from the same point of view as the paper of an individual member. Through the formation of the national sections, the work of the international committees can certainly be made more valuable and effective than ever before, for each national sub-committee, after having eliminated disagreements of its individual members, can work as a body to impress its views upon the other national sub-committees. In many cases an international agreement may be found difficult to make, but if made after such full discussion it will be sure to be authoritative and valuable.

The subject of the chemical analysis of iron and steel has been discussed in previous conferences and congresses, and at the Stockholm meeting of 1897 it was for-

mally resolved to establish an international sidero-chemical laboratory at Zurich. It was stated that fifteen smelting companies and iron manufacturers had pledged themselves to contribute $3,500 per year for this purpose, and that the Polytechnicum at Zurich had offered the use of four well-equipped rooms. It was, accordingly, determined to open the laboratory in 1898, and an international commission was appointed to take charge of it and raise further funds for its maintenance. I am unable to state how fully this has been carried out, as no published accounts of its work have appeared. It is, however, to be doubted whether the establishment of chemical and physical laboratories falls properly within the scope of the objects of the Association. If sufficient funds could be raised so that men of different nationalities might meet at such a laboratory to actually make analyses and tests, each criticizing the others, while at the same time learning from them, then undoubtedly effective work would be done in harmonizing differences and perfecting standard methods. It is to be hoped, if the establishment of the sidero-chemical laboratory at Zurich proves to be successful, that it may tend to further this method of research. It is, however, the opinion of many members that results as good, if not better, would be secured by arranging systematic schemes of investigation and distributing the actual work of analysis or testing among the laboratories of different countries.

A brief history of the organization and work of the International Association for Testing Materials, and of that of its American Section, has now been given. The great interest taken in the movement in so many countries is an index of the necessity felt in all branches of the engineering profession for the introduction of uniform methods of testing and inspecting the materials of construction. This work is one that must occupy many years, and which in a certain sense can never be finished, for constant progress will be made in our knowledge of the properties of materials. In order to carry it on with success it is apparent that more money will be needed than the small amount now raised from the annual dues of members. In Europe the importance of the work of the Association is forcibly attested by the fact that engineering societies, bureaus of public works, iron and cement manufacturers and railroads assist it by extra annual contributions, and it is to be hoped that the influence of this Section may be sufficient to cause similar substantial gifts to flow into its treasury from American corporations.

Since the above was written a circular of the International Council has been received, containing the information that probably arrangements cannot be made for holding the Congress of the Association at Paris in 1900. It appears that the authorities of the Paris Exposition have the right to control the organization of all Congresses held in that city in that year, and that they have announced one to be held on the subject of materials, and appointed officers to conduct the same. The subject will be discussed at this annual meeting, and expressions of opinion are desired as to whether it is best to abandon our Congress of 1900, in order to coöperate with the one announced by the authorities of the Paris Exposition, or to hold it at London during the week preceding.

In conclusion, it is with pleasure that I congratulate the American Section upon its activity and the Association itself upon the bright prospects before it. The undertaking inaugurated by Bauschinger and his associates bore good fruit at the conventions of 1884, 1886, 1888 and 1893, and prepared the way for the Zurich meeting of 1895, which was at the same time the fifth convention and the first Congress. At the

Stockholm Congress of 1897 the true international work was begun, and the problems there proposed are now the subjects of careful study in all parts of the earth. Let us hope that the reports to be presented at the future Congresses will be such as to add to the present stock of knowledge, prove advantageous to both producers and consumers, and assist all engineers in economically using the materials and forces of nature for the benefit of man.

Mansfield Merriman.
Lehigh University.

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*THE DEVONIAN SYSTEM IN CANADA.**

I.

To the student of the early literature of the Paleozoic rocks, and especially to the paleontologist, the name of William Lonsdale will always be associated with the Devonian System.

Although the term Devonian was first definitely proposed by Sedgwick and Murchison in a paper read April, 1839, and published in the fifth volume of the second series of Transactions of the Geological Society of London, the authors of this paper are careful to state (1) that "Mr. Lonsdale, after an extensive examination of the fossils of South Devon, had pronounced them, more than a year ago, to form a group intermediate between the Carboniferous and Silurian systems," and (2) that "the previous conclusions of Mr. Lonsdale * * * led the way to their proposed classification of the Cornish and Devonian formations."

Lonsdale, himself, in another paper printed in the same volume, distinctly claims that his suggestion, on the evidence of their fossils, that the South Devon limestones are "of an intermediate age between the Carboniferous and Silurian systems, and consequently of the age of the old red sandstone," was first made in December, 1837. S. P. Woodward, in the preface to the first part of his 'Manual of the Mollusca,' dated March, 1856, speaks of Lonsdale as his "friend and master, *the founder of the Devonian system in geology.*"

Yet so lately as in August, 1897, Mr. Marr is stated to have said* that "the Devonian system had been founded on stratigraphical grounds by Murchison and Sedgwick, and on paleontological grounds by Lonsdale and Etheridge." Surely it would have been more correct to have said that the existence of the Devonian as a distinct geological system was first indicated by Lonsdale in 1837 on purely paleontological evidence, and subsequently confirmed by Sedgwick and Murchison in 1839 on stratigraphical considerations.

However this may be, rocks of Devonian age have been discovered at various times in almost every province and district of the Dominion, and it is thought that a brief summary of the history of these discoveries and of the present state of our knowledge of the Devonian rocks of Canada, from a paleontologist's point of view, may be of interest on this occasion. In accordance with long usage in Canada, the line of demarcation between the Silurian and Devonian systems in this address will be drawn at the base of the Oriskany sandstone. It will also be convenient to consider the information that has so far been gained about the Devonian rocks of Canada in geographical order, from east to west, under the three following heads, viz.: (1) The Maritime Provinces and Quebec; (2) Ontario and Keewatin, and (3) Manitoba and the Northwest Territories.

I. THE MARITIME PROVINCES AND QUEBEC.

Nova Scotia.—In a memoir accompanying a geological map of Nova Scotia, by Dr.

* Address of the Vice-President and Chairman of Section E—Geology and Geography—of the American Association for the Advancement of Science, Columbus Meeting, August, 1899.

* *Quarterly Journal of the Geological Society of London,* Vol. LIII., page 460.

Abraham Gesner, published in the Proceedings of the Geological Society of London for May 10, 1843,* the following paragraph occurs:

"*Old Red Sandstone or Devonian group.*—Above the Silurian beds there occurs in several parts of the province, a bright red micaceous sandstone or conglomerate, accompanied by thin beds of red shale and marly clay, and in some places containing seams of fibrous gypsum. Hitherto no organic remains have been found in it. At Advocate Harbor and on the Moose River this sandstone is seen lying uncomformably beneath the coal measures. At the latter locality the sandstone dips W. 21° and the coal measures dip N. N. E. 60°. It is from a joint consideration of the mineral characters of this formation, and its relative position as compared with the coal measures, that the author has regarded it as the equivalent to the old red sandstone."

This would seem to be the earliest statement in regard to the occurrence of rocks of Devonian age in British North America, but Gesner then included in his old red sandstone group certain outliers of Carboniferous limestone and possibly Trias, that are now known to be associated with rocks still held to be Devonian.

Not quite two years later than this, in a paper read before the Geological Society of London on January 22, 1845, Sir William Dawson says that beyond Cape John the newer coal formation "seems to overlie, unconformably, a series of hard grits, slates and limestones, with scales of *Holoptychius*, Encrinites and fragments of bivalve shells, and which are probably of newer Silurian or Devonian age. The last-mentioned rocks, with various kinds of trap, form an elevated ridge belonging to the Cobequid chain of hills." †

Influenced, as he elsewhere tells us, by information supplied by Sir Charles Lyell, Gesner's earlier statements as to the Devonian rocks of Nova Scotia were modified in his 'Industrial Resources of Nova Scotia,' published at Halifax in 1849. In this volume the paragraph about the Devonian rocks is as follows:

"*Old Red Sandstone or Devonian Group.*—Above the Silurian strata there occur thick beds of conglomerate, bright red and micaceous sandstones, red shale and marly clay. At Advocate Harbor, Parrsboro,' Moose River, Horton, Shubenacadie and other places these rocks are seen dipping beneath the coal measures and gypsiferous red sandstones. The scales of fishes and other organic remains found in these deposits are too scanty and imperfect to afford conclusive evidence of their relative age; but from a joint consideration of them, the mineral character of the formation and its position, it may be classed as the equivalent of the old red sandstone of Europe or a part of the great carboniferous series. The strata contains but few minerals of importance."

The first edition of the 'Acadian Geology,' by Sir William Dawson, published in 1855, contains a 'Tabular View of Rock Formations in Nova Scotia,' in which the Devonian is defined as including the "fossiliferous slates of Bear River, Nictaux, New Canaan, Pictou, Arisaig, etc., and perhaps also parts of the metamorphic rocks of the Cobequid and Pictou, hills." In the fourteenth chapter of this volume the fossiliferous slates at Arisaig and the East River of Pictou are regarded as of Devonian age, on the authority of James Hall, but in a supplementary chapter, dated August, 1860, they are referred to the Silurian. Nine 'fossils from the Devonian and upper Silurian (?) rocks of Nova Scotia' are figured in this volume, but none of these are specifically determined and only three are Devonian. But, in the supplementary chapter, four of the fossils of the Nictaux and one of the Bear River series are determined specifically. Of the former it is stated that Hall "compares them with the fauna of the Oriskany sandstone, and they seem to give indubitable testimony that the Nictaux iron ore is of Lower Devonian age." A fuller list of fossils from Bear River and Nictaux, in which sixteen species

* Vol. IV., Part I., p. 187.

† *Quarterly Journal of the Geological Society of London*, Vol I., p. 235.

are described generically and nine specifically, was published in 1891.*

In the second and much enlarged edition of the 'Acadian Geology,' published in 1868, Sir William Dawson confirms and elaborates most of the statements about the Devonian of Nova Scotia in the first edition and 'Supplementary Chapter,' and figures a new Devonian Spirifer (*S. Nictavensis*) from Nictaux.† He notes the occurrence of 'obscure remains, evidently of land plants,' in more or less altered rocks on the flanks of the Cobequids, etc., and more particularly the discovery, in 1866, of "stipes of ferns, apparently of two species, a *Pinnularia*, and branching stems much resembling those of *Psilophyton*, a characteristic Devonian genus," in a gray altered sandstone or quartzite underlying unconformably a Carboniferous conglomerate at Bear Brook (now known as McCulloch Brook), near the Middle River of Pictou.

Doctor Honeyman, in a paper read before the Nova Scotia Institute of Natural Science in November, 1870, and since published in its Transactions, describes as of Devonian age a red band of argillites on McAra's and McAdams' Brooks, near Arisaig, which he calls the 'McAra's Brook Strata,' but in which he did not succeed in finding any fossils. Later collectors, however, have been more successful, and in 1885, Mr. T. C. Weston, of the Canadian Geological Survey, obtained from these argillites "fragments of plants and fish teeth not certainly determinable, together with certain interesting" imprints "like those of *Protichnites carbonarius*."‡ From the same rocks, in 1897, Dr. Ami and Mr. Hugh Fletcher, of the same survey, collected fragments of *Pterygotus* and of Pteraspidian and other fishes. The fish remains obtained in these rocks in 1897 have been examined by Mr. A. Smith Woodward, of the British Museum, who thinks that they are either uppermost Silurian or lowermost Devonian.

From 1872 to the present time Mr. Fletcher has been engaged in a minutely detailed examination of the geological structure of northern and eastern Nova Scotia, for the Geological Survey of Canada, which has published geological maps of a greater portion of this area on a scale of one mile to the inch. In 1887 he referred to the Devonian system the rocks below the Carboniferous conglomerate at Loch Lomond, Richmond County, Cape Breton.* From that point he has since traced rocks that he has described as Devonian, on stratigraphical and lithological grounds, westward through the peninsula of Nova Scotia as far as the head of Cobequid Bay and along both sides of Minas Basin, where he has estimated that they attain a thickness of from 10,000 to 15,000 feet.† With some Silurian and the associated igneous rocks, he believes them to form the mass of the Cobequids.

Most of these rocks that Mr. Fletcher refers to the Devonian had, however, previously been referred to other geological horizons. Among the more notable of these are the Horton series in Kings County, and the Riversdale series and Harrington River rocks in Colchester County. On purely paleontological evidence the Horton series had been referred to the Lower Carboniferous, and the Riversdale series to the Millstone Grit, by Sir William Dawson, though it is now pretty generally conceded that both are unconformably overlaid by a marine Carboniferous limestone.

* Acadian Geology, Supplementary Note to the Fourth Edition, pp. 20 and 21.

† Page 499, Figs. 176, *a*, *b*.

‡ Geological and Natural History Survey of Canada, Annual Report, New Series, Vol. II., p. 68 P.

* Geological Survey of Canada, Report of Progress for 1877–78.

† See the Annual Reports of the same Survey for 1877–78, 1879–80–81, 1886, and 1890–91.

Owing to circumstances it has unfortunately happened that very little paleontological work has been done in Nova Scotia or on Nova Scotian material since 1873. With the view of stimulating the prosecution of researches in this direction, collections of fossils have been made, during the past four years, and chiefly by Dr. Ami, of the Geological Survey of Canada, from many localities in the province, and some selected sets of these fossils have been forwarded to specialists.

In the Christmas and New Year's week of 1897 and 1898 Mr. David White, of the United States Geological Survey, examined the fossil plants from Nova Scotia and New Brunswick in the Peter Redpath Museum at Montreal and in the Museum of the Geological Survey at Ottawa. On the evidence of these plant remains Mr. White came to the following conclusions, which are summarized, by permission, from an unpublished report, in the form of a letter addressed to Dr. H. M. Ami, and dated January 12, 1898: (1) That the plant-bearing portion of the Horton series of Nova Scotia, as shown by Sir William Dawson in 1873, is nearly contemporaneous with the Pocono formation of the eastern United States, which has long been assigned to a basal position in the Carboniferous system. (2) That the Riversdale series of Nova Scotia (which Sir William Dawson referred to the Millstone Grit) is of Carboniferous age and assuredly newer than the Horton series. (3) That the plant-bearing beds near St. John, New Brunswick, are not Middle Devonian, as had previously been supposed, but Carboniferous, and that they are the exact equivalents of the Riversdale series of Nova Scotia.

Early in January last, collections of fossil plants from the Horton and Riversdale series and Harrington River rocks, at several localities in Nova Scotia, were sent to Mr. R. Kidston, of Stirling, Scotland, an experienced paleo-botanist, for examination and study. In a manuscript report upon these collections, addressed to the Director of the Canadian Survey, and received May 8, 1899, Mr. Kidston comes to almost exactly the same conclusions as those previously arrived at by Mr. White, and on perfectly independent grounds. In this report Mr. Kidston expresses the following opinions: (1) Of the Horton series he says: "These rocks appear to be undoubtedly Lower Carboniferous." "There is no evidence at all to support the opinion that they are of Devonian age." "All the evidence derived from a study of their fossils points very strongly against this view." (2) Of the Riversdale series he says: "The two divisions of this series, the Riversdale Station and Harrington River rocks, may be treated together, as they contain the same fossils and are evidently of the same age." The whole of the fossil plants from the Riversdale series have a most pronounced Upper Carboniferous facies and markedly possess the characteristics of a Coal Measure Flora. "Judged from a European comparison, no other conclusion can be arrived at." (3) Lastly, he says that "the question of the age of the Riversdale series is inseparably connected with the question of the age of the plant beds of St. John, New Brunswick." "The species contained in the Riversdale series are also met with in the St. John plant beds, where, however, a greater number of species has been discovered." "I do not," he adds, "wish to express my views as to the age of the St. John plant beds too strongly, but, from what I have been able to learn from a study of the literature of the subject and an examination of specimens from these beds, it appears to me that they possess a flora of a much higher horizon than that assigned to them, and that in reality they are most probably Upper Carboniferous." "It must, however, be remembered that since Sir William Dawson

wrote his work on the Pre-Carboniferous Flora very much has been done in Europe to work out the zones of the Coal Measure Flora, and careful and accurate figures have been published which did not exist at the time he was carrying out his investigations." "A thorough revision of the work, especially in the light of subsequent collections and possible discovery of more perfectly preserved specimens, seems most desirable, and also that a better series of figures be published."

As complete a collection as possible of the fish remains of the Horton and Riversdale series of Nova Scotia was sent to Mr. A. Smith Woodward, in January, 1899, for examination and study, but no report upon these specimens has yet been received.

The Devono-Carboniferous problem in Nova Scotia and New Brunswick is far too complicated a question to be discussed at any length in an address of this kind. At present, however, it is obvious that there is some discrepancy between the views of the two geologists on the Canadian Survey staff, who have studied the question from a stratigraphical and lithological point of view, and those of the paleontologists whose names have been cited in this connection, as to the age of the Horton and Riversdale series of Nova Scotia, and of the plant-bearing beds near St. John, New Brunswick.

New Brunswick.—It would appear that Devonian rocks, or at any rate rocks that have for many years been regarded as of Devonian age, were not recognized in New Brunswick until 1861. For, although Dr. Gesner made extensive geological explorations in the province last named, from 1838 to 1843, the strata that he refers to the old red sandstone, in his first report on a geological survey thereof, published in 1839, and in a short paragraph in chapter eleven of his volume on New Brunswick, published in 1847, are now regarded as of Carboniferous age.

The occurrence of fossil plants in rocks near St. John was noticed by Dr. Gesner as early as in his second report on the Geology of New Brunswick, published in 1840, and Sir William Dawson states that a well-characterized specimen from these rocks, which he subsequently identified with the *Calamites transitionis* of Goeppert, was shown to him by the late Professor Robb in 1857.*

In 1860 a small collection of fossil plants from the shales at the foot of the city of St. John, near the barracks, recently made by Dr. G. F. Matthew, was submitted to Sir William Dawson for examination. On the evidence of their fossil plants these rocks at St. John were referred to the Devonian system by Sir William, in a paper 'On the Pre-Carboniferous Flora of New Brunswick, Maine and Eastern Canada,' published in the *Canadian Naturalist and Geologist* for June, 1861. Seven species are recognized in this collection, six of which are described as new. Professor L. W. Bailey, in his Report on the Geology of Southern New Brunswick, says that "the same author in June, 1861, after an examination of certain fossils in eastern Maine, asserted the Devonian age of the rocks containing them, and also of the sandstones constituting the peninsula of St. Andrews, which they closely resemble."

Immediately after this, rocks containing similar fossils, and presumably, therefore, of Devonian age, were recognized at other localities in the neighborhood of St. John, or in St. John county, as at the Little and Mispec rivers, and more particularly at the Fern Ledges, in Lancaster parish. From the latter locality extensive collections or fossils were made by Dr. Matthew, Professor Hartt and other local collectors in 1861, 1862 and 1863, and more recently by Mr. W. J. Wilson and Dr. Matthew. The luxuriant and singularly varied fossil flora of the Fern Ledges has been described by

* Acadian Geology, Second Edition, p. 502.

Sir William Dawson in 1862,* by Professor Hartt in 1865,† by Sir William Dawson and Professor Hartt in 1868,‡ and by Sir William Dawson in 1871§ and 1882.|| The 'revised list of the Pre-Carboniferous plants of N. E. America' in the first part of Sir William's memoir on 'the fossil plants of the Devonian and Upper Silurian formations of Canada,' published by the Dominion Survey in 1871, contains the names of seventy species of fossil plants from the Devonian of New Brunswick, nearly all of which are from the Fern Ledges. In the second part of the same memoir, published in 1882, two additional species were described.

The remarkable assemblage of air-breathing articulata and mollusca associated with these plant remains has been described by Salter in 1863,¶ by Scudder in 1868,** by Sir William Dawson in 1880,†† and by Dr. Matthew in 1888‡‡ and 1894.§§. In the latter of these two papers Dr. Matthew states that the "air-breathing articulates of the plant-bearing bed of St. John so far recognized consist of:

Insects, nine species of eight genera	9
Myriapods, six species of several genera	6
Arachnid similar to Anthracomartus	1
Probable pedipalp. (*Eurypterella*)	1
Probably Arachnid or Isopod (*Amphipeltis*)	1
Scorpion (*Palæophonus arctus*)	1

"Two species of land snails have also been found, raising the number of air-breathing animals found in the plant-beds of St. John to twenty-one kinds."

Elsewhere in this paper Dr. Matthew says that "later discoveries lead the author to think that *Eurypterus pulicaris*, Salter, should be referred to the myriapods or to the insects," and in the foregoing list it is evidently included with the insects. To this list, also, should be added a trilobite and an annelid (*Spirorbis Erianus*, Dawson), which indicate marine or at least brackish water conditions, while from the description and figures it is difficult to see in what respects the very imperfect specimen described as a land shell under the name *Strophites* (since changed to *Strophella*) *grandæva* differs from the presumably marine genus *Macrocheilus*.

Detailed description of the stratigraphical relations of the presumed Devonian rocks near St. John, by Dr. Matthew, were published in 1863* and 1865,† and many additional facts in relation thereto are contained in Professor Bailey's Report on the Geology of Southern New Brunswick, published in 1865. In 1863 Dr. Matthew gave the local and provisional names of the Mispec, Little River and Bloomsbury groups to the subdivisions of the supposed Devonian system in St. John county, the Little River group, including both the Cordaites shales of the Fern Ledges, with their numerous fossil plants, insects, etc., and the Dadoxylon sandstone. The Little River group was at first supposed to be of Upper Devonian age; but, in consequence of the investigations of Professor Bailey and Dr. Matthew in 1870, Sir William Dawson, in 1871, expressed the opinion that the Mispec group represents the Upper Devonian, the Little River group the Middle Devonian, and the Lower Conglomerates (presumably the

* *Quarterly Journal of the Geological Society of London*, Vol. XVIII., pp. 296–330.

† In an Appendix to Professor Bailey's Report on the Geology of Southern New Brunswick.

‡ Acadian Geology, Second Edition, pp. 534–556.

§ Geological Survey of Canada. Fossil Plants of the Devonian and Upper Silurian Formations of Canada.

|| *Ibid.*, Part 2.

¶ *Quarterly Journal of the Geological Society of London*, Vol. XIX., pp. 75–80.

** Acadian Geology, Second Edition, pp. 523–526.

†† *American Journal of Science*, Vol. XX., p. 413.

‡‡ Transactions of the Royal Society of Canada, Vol. VI., Sec. 4, pp. 57–62.

§§ *Ibid.*, Vol. XII., Sec. 4, pp. 95–100.

* *Canadian Naturalist and Geologist*, Vol. VIII., pp. 241–259.

† *Quarterly Journal of the Geological Society of London*, Vol. XXI., pp. 429–30.

Bloomsbury group) the Lower Devonian. Matthew, in 1888, after stating that there is one unconformity between the Perry sandstone and the Mispec beds and another between the Mispec beds and the Cordaite shales, thus redivides the Devonian rocks of St. John county, the unconformities being marked by a dividing line.

"Perry Sandstones with Upper Devonian flora, according to Sir J. W. Dawson, but lithologically representing the Lower Carboniferous sandstone.

"Mispec Conglomerate and slate.

"Cordaite shales and flags, Middle Devonian flora. *Insect remains* (in oldest beds of the Cordaite shales).

"Dadoxylon sandstone (with an older Devonian flora, G. F. M.).

"Bloomsbury Conglomerate, etc."*

On behalf of the Canadian Survey, in 1870, Professor Bailey and Dr. Matthew traced beds corresponding to the plant-bearing beds near St. John as far to the westward as Lepreau Harbor, in Charlotte county, where many fossil plants like those at the Fern Ledges were collected. Ten years later the distribution of the Devonian rocks in the southern part of the province, as far as then known, was thus summarized by Messrs. Bailey, Matthew and Ells :

"The areas of Devonian occurring in southern New Brunswick may be stated as follows :

"1. A large basin, or double synclinal, east of St. John Harbor, occupying the valley of the Mispec, with a southern area extending northeasterly across the Black River, near the forks of the East Branch.

"2. Isolated outcrops on Coal Creek and on Canaan River and North Fork, presumably of this age, but lacking evidence of fossils.

"3. Small areas about St. John and Carlton, with possibly Partridge Island.

"4. A small area about the eastern extremity of Spruce Lake, on the St. Andrews Railroad.

"5. A belt stretching west from Musquash Harbor to Lepreau Harbor, in which is contained the so-called anthracite mine of Belas Basin, with a smaller detached area along the shore from By Chance Harbor to Dipper Harbor.

"6. A large area in the northern part of Charlotte county, embracing the former pale argillite series and extending into Queen's county."*

Prior to 1894 the Devonian age of these rocks had never been called in question. But, in a footnote to page 79 of Sir William Dawson's 'Synopsis of the Air-Breathing Animals of the Palæozoic Period in Canada up to 1894,' published in the Transactions of the Royal Society of Canada for that year, Dr. Matthew says of the Little River group (which includes the plant-bearing beds near St. John) that he has "recently found some reason to suspect that these beds are as old as Silurian." And, as already stated in connection with this phase of the Devono-Carboniferous problem in Nova Scotia, both Mr. White and Mr. Kidston, on the evidence of their plant remains, have independently and quite recently expressed the opinion that the plant-bearing beds near St. John are the exact equivalents of the Riversdale series of the Nova Scotia Carboniferous.

In northern New Brunswick an area of gray shale (with *Psilophyton*) and conglomerates, which are regarded as of Devonian age, on the east side of the St. John River, near the mouth of the Beccaguimic, is indicated in a map accompanying Dr. Ells' 'Report on the Iron-ore Deposits of Carleton County,' in the 'Report of Progress of the Geological Survey of Canada for 1874–75.' Dr. Ells, also, in the 'Report of Progress' of the same Survey for 1879–80, says that areas of Devonian rocks are "seen at intervals along the lower Restigouche River," and that they "form a synclinal basin extending from near the town of Dalhousie westward to a point about two miles above Campbellton and terminating on the south side of the river at Old Mission Point." This report is descriptive of explorations made in 1879, and in it the Devonian age of

* Transactions of the Royal Society of Canada, Vol. VI., Sec. 4, p. 61.

* Geological Survey of Canada, Report of Progress for 1878–79, p. 11 D.

the rocks at Campbellton is assumed exclusively on the evidence of a few fossil plants (*i. e.*, two species of *Psilophyton*, one of *Lycopodites* and one of *Cordaites*) that had been identified and described by Sir William Dawson. The remarkable fish-fauna at Campbellton was not discovered until June 27, 1881, but it will be more convenient to consider it later on, in connection with the equally notable fish-fauna discovered in 1879, on the opposite side of the lower Restigouche River at Scaumenac Bay, in the Province of Quebec, as the two localities are only about sixteen miles apart. Another area of Devonian rocks in the northern part of the province is that on the Upsalquitch River, discovered by Dr. Ells in 1879 and described also in the 1879–80 report.

Quebec.—The Geological Survey of Canada was instituted in August, 1842, but prior to the confederation of the provinces in 1867 the scope of its operations extended only over Upper and Lower Canada, now known as the Provinces of Ontario and Quebec.

With the view of ascertaining whether the coal measures of New Brunswick did or did not extend into Canada, its first Director, Sir W. E. Logan, devoted the summer seasons of 1843 and 1844 to a geological examination of the Gaspé peninsula and of the country between it and the Baie des Chaleurs. In 1843 he surveyed the coast from Cap Rosier to Paspebiac, and in 1844 the exposures between Cap Rosier and Cape Chatte, thence following the Chatte River to the Cascapedia and crossing to the Baie des Chaleurs. During these two years the main geological features of the part of the province examined were, for the first time, definitely ascertained, and the absence of any productive coal measures north of the Baie des Chaleurs demonstrated. In 1843 the sandstones and limestones of Gaspé Bay, since known as the Gaspé sandstones and limestones, were carefully studied and their fossils collected. In 1844 the Gaspé sandstones were traced for a considerable distance up the St. Lawrence, and in the 'Report of Progress' of the Survey for 1847–48 they are said to extend from the very extremity of the Gaspé district to Matapedia Lake, a distance of 150 miles, and their thickness is estimated at 7,000 feet.

As early as 1845, if not in 1844, the Devonian age of the Gaspé sandstones was recognized by Logan. In the Annual Report of the Survey, under his direction for 1844 (which, though written in 1845, was not published until 1846), these sandstones are said to "resemble the Chemung and Portage groups of the State of New York, with perhaps the addition of what the geologists of that State term their old red sandstone" (*i. e.*, the Catskill group), and to be overlaid by the Carboniferous series. At that time the Gaspé sandstones were regarded as of Upper Devonian age, but the numerous fossils that Logan had collected from them had not then been critically studied by any competent paleontologist. In an entry in his notebook for August 20, 1843, published in the 'Life of Logan' by Dr. Harrington, it is distinctly stated that the plants of these sandstones are 'not Carboniferous.' A few years later, in a communication to the meeting of the 'British Association for the Advancement of Science' at Ipswich, in 1851, Logan thus expresses himself: "None of the productive part of the New Brunswick coal measures reaches Canada, but there comes out from beneath it, on the Canadian side of the Bay Chaleurs, 3,000 feet of Carboniferous red sandstones and conglomerates. These are succeeded by 7,000 feet of Devonian sandstones, which rest upon 2,000 feet of Silurian rocks consisting of limestones and slates."*

Six of the species of fossil plants collected from the Gaspé sandstones by Logan in

* Report of the Twenty-first Meeting, page 61.

1843 were described by Sir William Dawson: four (*Psilophyton princeps*, *P. robustius*, *Lepidodendron Gaspianum* and *Prototaxites Logani*) in the *Quarterly Journal of the Geological Society of London* for January, 1859;* and two (*Cordaites angustifolia* and *Selaginites formosus*) in the *Canadian Naturalist and Geologist* for June, 1861. In the former of these papers the two remarkable genera *Psilophyton* and *Prototaxites* were first proposed and defined. Subsequently, however, in 1888, Sir William somewhat modified his earlier descriptions of *Prototaxites* and changed its gêneric name to *Nematophyton*.† *Selaginites formosus* was abandoned 'as a vegetable species' by its author in 1871, because additional material showed that the specimens upon which it was based are 'probably fragments of some Eurypteroid crustacean,'‡ as suggested by Mr. Salter.

The supposed worm-tracks from the Gaspé sandstone between Tar Point and Douglastown, discovered by Logan in 1843, were described and refigured by the writer, under the name of *Gyrichnites Gaspensis*, in the Transactions of the Royal Society of Canada for 1882.

Logan's examinations of the Gaspé series of sandstones and limestones were supplemented by those of Murray on the Douglastown and St. John rivers in 1845; of Richardson on the Magdalen River and upper part of the Dartmouth in 1857, and of Bell of the Dartmouth, York and Malbaie rivers in 1862. Sir William Dawson also made extensive collections of fossils around the shores of Gaspé Bay in 1858 and 1869, and Dr. Ells a general geological survey of the Gaspé peninsula, from Gaspé Basin to the Matapedia River and from the St. Lawrence River to the Baie des Chaleurs in 1880–83, and a similar survey of the Devonian basin of the Causupscal River in 1884.

The collections made by Sir William Dawson in 1869 added thirteen additional species of fossil plants to the flora of the Gaspé sandstones, and these species were described and illustrated in the first part of his memoir on the 'Fossil Plants of the Devonian and Silurian Formations of Canada,' published by the Canadian Survey in 1871. The 'Geology of Canada,' published in 1863, contains lists of some of the marine invertebrate fossils of the Gaspé limestones and sandstones, collected by Logan, Dawson and Bell, and these fossils were more fully determined or described by E. Billings in the first part of the second volume of Paleozoic Fossils, published by the Canadian Survey in 1874. A small species of *Cephalaspis*, also, collected by Professor G. T. Kennedy, then one of Sir William Dawson's assistants, from the Gaspé sandstones on the north side of Gaspé Bay in 1869, was described and printed by Professor Ray Lankester, in the *Geological Magazine* for September, 1870,* under the name of *C. Dawsoni*.

In the 'Geology of Canada' it is stated that the "limestones of Cape Gaspé appear for the most part to belong to the Lower Helderberg group." * * * "The fossils at the summit, however, bear a striking resemblance to those of the Oriskany formation, with which several of them are identical. It appears probable, therefore, that we have a passage from the Lower Helderberg to here the Oriskany, and the latter formation may be more especially represented by the lower part of the Gaspé sandstones." Eleven years later, in 1874,† E. Billings expressed the opinion that the lower 330 feet of the Gaspé

* Vol. XV., p. 477.

† The Geological History of Plants, page 21; and Transactions of the Royal Society of Canada for 1888, Sec. 4, pp. 27–47.

‡ Geological Survey of Canada. The Fossil Plants of the Devonian and Upper Silurian formations of Canada, Part 1, p. 65.

*Volume VII., p. 397.

† Geological Survey of Canada. Paleozoic Fossils, Vol. II., Pt. 1, p. 1.

limestones are Upper Silurian (Lower Helderberg), the middle 880 feet passage beds, and the upper 800 feet Devonian.

At the other end of the province a small area of rocks on the Famine River, in Beauce county, and another on the west side of Lake Memphremagog, in the county of Brome, were recognized as Devonian by Logan in 1863.*

Quite recently, too, a re-examination, by Mr. Schuchert, of some of the brachiopoda from the small masses of limestone on St. Helen's Island, opposite Montreal, has shown that these limestones are probably the equivalents of part of the Hamilton formation of Ontario and New York, and not of the Lower Helderberg.

Although the Devonian system is preeminently the Age of Fishes, yet for many years scarcely any remains of fossil fishes had been found in the Devonian rocks of Canada that are at all closely comparable with those of the old red sandstone of Scotland and Russia. As early as 1842, however, the rocks on both sides of the lower Restigouche River were examined by Dr. Gesner, who says that he found the "remains of fish and a small species of tortoise, with fossil foot-marks,"† in the shales and sandstones at Escuminac (now called Scaumenac) Bay, which he supposed were of Carboniferous age. The statement in regard to the fossils at this locality attracted no particular attention at the time, but in September, 1879, Dr. Ells found a natural mould of the exterior of the ventral surface and of one of the lateral appendages of a Pterichthys-like fish in a concretionary nodule at Scaumenac Bay, and in June, 1881, remains of a species of *Cephalaspis* in the brecciated limestones near Campbellton. The first of these discoveries led to further investigations by officers of the Canadian Survey in 1880, 1881 and 1882, which revealed the existence of a remarkable assemblage of fossil fishes and land plants of Upper Devonian age at Scaumenac Bay, and of an entirely different series of fishes and plants of Lower Devonian age on the opposite, or New Brunswick side of the river, near Campbellton. Large collections were made at each of these localities, especially of the fossil fishes, which were described by the writer in 1880,* 1881† and 1883,‡ and described and illustrated in 1887§ and 1889.‖ Many of these specimens were exhibited at the meeting of this Association at Montreal in 1882.

In the collections from Scaumenac Bay made up to 1882 and described by the writer the Elasmobranchii are represented by two species of *Acanthodes* (*A. concinnus* and *A. affinis*); the Ostracodermi by numerous, remarkably well-preserved and nearly perfect specimens of a *Bothriolepis* (*B. Canadensis*) which Gesner seems to have thought was a small tortoise; the Dipnoi by a supposed *Phaneropleuron* (*P. curtum*), the type of Traquair's subsequently described genus *Scaumenacia*,¶ and the Teleostomi by a *Glyptolepis* (*G. Quebecensis*), a *Cheirolepis* and a new genus (*Eusthenopteron*) closely allied to *Tristichopterus*. A few of the superficial and presumably sensory grooves on the cranial shield of the Canadian *Bothriolepis* were mistaken for sutures, as the similar ones of the European species had been by Lahusen, but

* Geology of Canada, pp. 428–436.

† Report on the Geological Survey of the Province of New Brunswick, etc., St. John, 1843, p. 64.

* *American Journal of Science*, Vol. XX., p. 132; and reprinted in the *Canadian Naturalist and Geologist*, Vol. X., p. 23.

† *American Journal of Science*, Vol. XXI., p. 94; and reprinted in the *Annals and Magazine of Natural History*, Fifth Series, Vol. VIII., p. 159; and *Canadian Naturalist and Geologist*, Vol. X., New Series, p. 27 and p. 93.

‡ *American Naturalist*, Vol. XVII., p. 158.

§ Transactions of the Royal Society of Canada, Vol. IV., Sec. 4, p. 101.

‖ *Ibid.*, Vol. VI., Sec. 4, p. 77.

¶ *Geological Magazine*, June, 1893, Decade 3, Vol. X., p. 262.

some of the specimens of that genus from Scaumenac Bay threw quite a new light on the structure of its mouth organs and of the so-called 'lid' with its pineal element. And, similarly, a portion of one side of the head of a specimen of *Eusthenopteron* from the same locality, which by an oversight was referred to *Phaneropleuron*, has almost all the sclerotic plates of the eye preserved.

From the collections made near Campbellton in 1881 and 1882 four species of fossil fishes were described, viz.: *Cephalaspis Campbelltonensis;* a supposed *Coccosteus* (*C. Acadicus*), the type of Traquair's subsequently characterized genus *Phlyctænaspis*,* and two kinds of fin spines.

Numerous fossil fishes from both of these localities have since been collected by Mr. Jex for Mr. R. F. Damon, of Weymouth, England, and these have been acquired by the Edinburgh and British Museums. These later collections have yielded some additional species, one from Scaumenac Bay, which was described by Dr. Traquair in 1890, and six from Campbellton, three of which were described by Dr. Traquair, one in 1890 and two in 1893, and three by Mr. A. Smith Woodward in 1892. The latest novelty from Scaumenac Bay is a new *Cephalaspis* (*C. laticeps*, Traquair), of which it is said that "this is the first occurrence of a cephalaspid in rocks of later age than the Lower Devonian."† The three additional species from Campbellton that Dr. Traquair has described are two ichthyodorulites (*Gyracanthus incurvus*‡ and *Cheiracanthus costellatus*)§ and another *Cephalaspis* (*C. Jexi*).|| The three from the same locality described by Mr. A. Smith Woodward, in the eighth volume of the Third Decade of the *Geological Magazine*, are all elasmobranchs, viz., *Acanthodes semistriatus*, *Protodus Jexi* and *Diplodus problematicus*, the latter being the type of Traquair's genus *Doliodus*,* published in 1893.

In 1882 Sir William Dawson determined or described the fossil plants from Scaumenac Bay, four specifically and four only generically, and identified six species of fossil plants from near Campbellton with the *Psilophyton princeps*, *P. robustius*, *Arthrostigma gracile*, *Leptophlœum rhombicum*, *Cordaites angustifolia* and *Prototaxites Logani* of the Gaspé sandstones. He asserts that the plant and fish-bearing beds at Scaumenac Bay are "no doubt the equivalents and continuation of the upper part of the Gaspé sandstones," and that the fossil plants from near Campbelltown are "perfectly identical with the lower part," of these sandstones.†

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(*To be concluded.*)

* *Geological Magazine*, Decade 3, Vol. VII., p. 144.

† *Ibid.*, Decade 3, Vol. VII., p. 16.

‡ *Ibid.*, p. 21.

§ *Ibid.*, Decade 3, Vol. X., p. 146.

|| *Ibid.*, p. 147.

* *Ibid.*, p. 145.

† Geological Survey of Canada. The Fossil Plants of the Erian (Devonian) and Upper Silurian Formations of Canada. Part 2.

THE FAMILY NAME OF THE DORMICE.

IN a paper 'On the Genera of Rodents,' published in 1896,‡ Mr. Oldfield Thomas very properly rejected the family name Myoxidæ commonly applied to the Old World dormice, for the reason that *Myoxus*, on which it was based, is a synonym of the earlier generic name *Glis*. In adopting the name Gliridæ he divided the family into two subfamilies, Glirinæ and Platacanthomyinæ; the former including four genera: *Glis* Brisson, 1762; *Muscardinus* Kaup, 1829; *Eliomys* Wagner, 1843, and *Graphiurus* Cuvier, 1838; the latter *Platacanthomys* Blyth, 1859, and *Typhlomys* Milne-Edwards, 1877. It now appears that Gliridæ is untenable for this family because of previous application to other groups; in

‡ Proc. Zool. Soc. London, 1896, p. 1016.

short, that it is one of the rare examples of a term preoccupied as a family name but based on a genus which is perfectly valid.

Nearly eighty years ago Wiegmann* proposed the family Glirina for the wombats (*Phascolomys*) of Australia and Tasmania, which are now referred to the Phascolomyidæ. This course was also followed by Wagner in 1855, in the Supplement to Schreber's Säugthiere (Vol. V., pp. xv, 332).

In 1837 Ogilby,† in discussing the relationships of the peculiar aye-aye (*Cheiromys*) found in Madagascar, remarked: "It is only, indeed, the absence of the marsupial character which would make us hesitate to unite the *Cheiromys* with the Didelphidæ; but this circumstance is so material as to require that it should be placed in a different subfamily. At the same time, its analogy to the Rodentia ought not to be overlooked; and it is for the purpose of expressing this relation that I propose to denominate the small group which I am obliged to form for this animal, Gliridæ. I suspect, indeed, that the *Cheiromys* bears a more intimate relation to the real dormice (*Glis*) than we are yet aware of."

Thus Gliridæ has been used for three different groups of mammals belonging to as many different orders, Marsupialia, Primates and Rodentia. But since it is generally recognized that family names must be based on one of the included genera, this name is not available either for the aye-aye or the wombat, while its prior application to these animals invalidates its later use for the dormice, the only group which contains a genus *Glis*.

It remains to be determined what family designation should be applied to the dormice. Besides *Glis* and its synonym *Myoxus*, two other genera have been selected as types of higher groups: *Platacanthomys*, made the type of the subfamily Platacanthomyinæ by Blyth in 1876, and *Graphiurus*, the type of the subfamily Graphiurini by Winge in 1887. Either of these names might be used for the family. Platacanthomyinæ has the advantage of priority, but is open to the objection that it represents an aberrant section, so different, in fact, that some authors have not associated it with the dormice at all. *Graphiurus* is also aberrant, and according to Winge should be separated from all the other genera. This view Thomas does not accept, holding that "it might be quite as correct to separate *Glis* and *Muscardinus* on the one side from *Eliomys* and *Graphiurus* on the other by the pattern of the teeth, as to separate the last-named from the rest by the structure of the anteorbital region." Evidently a family based on the Indian *Platacanthomys* or the South African *Graphiurus* would not represent exactly the same group as that formerly known as Myoxidæ.

Under these circumstances it seems desirable to adopt a new family name, Muscardinidæ, based on *Muscardinus*, a genus which is closely related to *Glis*. The family of dormice may then be subdivided into the Muscardininæ for *Muscardinus*, *Glis*, *Graphiurus*, *Eliomys*; and Platacanthomyinæ for *Platacanthomys* and *Typhlomys*, reserving Winge's Graphiurinæ for *Graphirus* and *Eliomys*, in case it should be desirable to make a third subfamily for these genera, as suggested by Thomas.

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* Wiegmann & Ruthe's Handbuch d. Zool., p. 52, 1832.

† *Charlesworth's Mag. Nat. Hist.*, I., p. 523, Oct., 1837.

SCIENTIFIC BOOKS.

Differential and Integral Calculus for Technical Schools and Colleges. By P. A. LAMBERT, M.A., Assistant Professor of Mathematics, Lehigh University. New York, The Macmillan Company. 1898. Pp. x+245. Price $1.50.

An Elementary Course in the Integral Calculus. By Daniel Alexander Murray, Ph.D., Instructor in Mathematics in Cornell University. New York, Cincinnati, Chicago, The American Book Company. 1898. Pp. xiv + 288. Price.

The late Judge Cooley, it is said, made it a point to advise his students never to buy a law book not containing a suitable index. If Professor Lambert's book were provided with this common convenience and with a table of answers and if the pages were less crowded and the margins not so narrow, the size of the volume, which contains fourteen chapters including three dealing with differential equations, would more nearly agree with its scope. Even then, however, the book would belong, where the author doubtless intended it should belong, to the class of text-books which in order to distinguish them from their more comprehensive and cumbrous rivals, are sometimes described as thin. It is hardly to be imagined that, among those extra-scientific features of a book that may properly be considered in determining its acceptability as a text-book for classes, mere thinness could count for much. Certainly a slight difference of length, breadth, thickness or weight could not be decisive. Perhaps the most competent teachers are apt to prefer the thin text-book as less likely to dishearten and overwhelm the beginnner by multiplicity and as leaving more room for personal view-point and individuality; but then the least competent, too, are, for obvious reasons, prone to the like preference. In this case the thin book will prove friendly to sciolism rather than to knowledge, as the student will hardly escape the impression that the science is as thin as the book.

The English is in general clear, precise and correct. The style is, however, uniformly dry, the reader being soberly conducted through the 'enchanted realm of open mystery' with scarcely a change of mood or variation of pulse. Books for boys, however logical and scientific, one could wish might be more vital and vitalizing, more human, more cheerful and sympathetic, addressed not so exclusively to the analytic and formularizing powers, but to the appreciation also, to the faculties of estrangement and curiosity, of wonder and admiration, looking not less towards knowledge but more towards culture. But even if we may not rightfully expect inspiration, we may, at all events, demand direction, orientation, judicious accentuation. The author does occasionally remark that some notion is fundamental, but in general the student is left to his own resources for discriminating the more from the less important matters. Cardinal theorems, at least, might have received the common emphasis of italics.

The first hundred pages are concerned with algebraic functions, which, by the way, again receive the old definition. Transcendental functions follow. Integration, in which considerable use is made of trigonometric substitutions, is throughout treated simultaneously with differentiation. By this arrangement, it became possible to introduce at an early stage a goodly variety of physical, geometric and engineering problems which serve to illustrate the practical utility of the calculus. In addition, by way of encouraging practice, numerous exercises, invariably called problems, have been inserted.

The author desires 'by a logical presentation of principles to inspire confidence in the methods of infinitesimal analysis.' It is really not at all necessary. College atmosphere is saturated with belief in the validity and power of this subtile analysis. The faith is acquired by a kind of 'cerebral suction.' The average student has too much of this 'confidence' even before he begins the study, and as a rule too much also at the end. A genuine intellectual conviction, though it may not follow doubt, certainly can not precede it; and the rigorist's first object would seem to be not to inspire, nor to preserve, but rather to mitigate the student's unearned confidence. To beget a wholesome skepticism is an indispensable preliminary, but this is as little undertaken in this book as in the majority of its competitors.

It should by no means be inferred that the book is devoid of modern elements. The notions of absolute and uniform convergence, for example, are introduced, and the conditions for term-by-term integration and differentiation of power-series are considered; but the work is not preëminently 'logical.' The infinitesimal

is regarded as 'a quantity which becomes indefinitely small.' According to the definition of limit, page 3, either of two *variables*, as $\frac{1}{2^n}$, $\frac{1}{3^n}$, n increasing, may be the limit of the other. On page 10 we are told that when a point, moving continuously on a given curve, passes a specified point of the latter, it tends at that instant to move on the tangent. There is, of course, no such tendency, and continuity is not defined till several pages later. On page 25 the conclusion, 'Hence the first derivative, etc.,' is, as stated, entirely unwarranted by the premises. 'Any finite constant' is much too sweeping. It appears to be assumed throughout that continuity implies derivability. The explanations of the differentials dy and dx, pp. 39, 40, are interesting and curious. It would be supererogatory to give here an exhaustive enumeration of the peculiarities encountered, the foregoing specimens, taken at random, being perhaps sufficient.

The final three chapters present plainly and pleasantly an introduction to the practical phase of differential equations. The existence theorem, naturally not proved, is however *tacitly* assumed, and such fundamental questions as whether all modes and orders of elimination lead to the same equation are neither met nor propounded.

Dr. Murray's book is a simple, fresh, luminous and suggestive presentation of the elementary subject-matter of the integral calculus. While it was written primarily for engineering classes and particularly adapted to conditions prevailing at Cornell University, still the needs of others have been regarded and the work is not ill-suited as a guide to any one beginning the study of this branch of mathematics. The first two chapters, in particular, furnish an unusually full account of fundamental concepts and operations. The two conceptions of integration, as the inverse of differentiation, and as a process of summation, are shown to be one. On pages 9 and 11 and elsewhere, the symbol $\int$ is spoken of as denoting now a sum and again the limit of a sum, with seeming indifference.

Chapter XII. deals briefly with the important subject of integral curves, and in the next chapter, which is final, we find a brief discussion of some common and important differential equations.

For the convenience of any who may not have the time—several months, at least—necessary for the mastery of all the matter offered, a list of lessons for a shorter course is suggested. Many other minor features help to enhance the acceptability of the book. The exercises are numerous and many of them are not found in other works. A table of answers is appended as also a short table of integrals. Binding and paper are substantial and printing and proof-reading well done. There is no great pretense of rigor but there is life. The book was not stillborn.

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COLUMBIA UNIVERSITY.

GENERAL.

THE Adjutant-General's office of the War Department has undertaken the issue of a 'French-English Military Technical Dictionary,' compiled by Cornélis De Witt Willcox, first lieutenant of artillery, U. S. Army. The first part, which has just been issued, contains 160 pages and reaches the word *espace*. The book is clearly printed with a judicious use of block and italic type. It will prove useful not only in the army and navy, but also to students of science in different directions. Many of the words translated will not be found in a good French dictionary as 'Littré et Beaujean,' yet they occur in scientific books. Not many Americans could give the equivalent of words such as *abouement*, *abougri*, *abraquer*, etc., and it is convenient to have at hand a dictionary in which they can be found. It is a matter for congratulation that there are in the army officers capable of such good scientific and literary work, and that it is encouraged by the authorities.

THE Experiment station of West Virginia University has recently issued Bulletin, No. 56, prepared by Dr. Hopkins, summing up the work done by him as entomologist of the Station during the past eight or nine years. This is a large bulletin of over 360 pages, and contains much valuable data collected by the entomological department during the time named, as it

gives the results of investigations, both in this country and Europe, relative to the spruce and pine interests, and the insects predaceous and beneficial to them.

Messrs D. Appleton & Co. announce the following new volumes in their library of 'Useful Stories:' 'The Living Machine,' by Professor H. W. Conn; 'The Alphabet,' by Edward Clodd and 'Organic Chemistry,' by Professor G. F. Chambers.

The continuation of several important publications by The Macmillan Company, namely the second volume of the 'Scientific Papers,' by John Couch Adam; the third volume of the text-books of 'Embryology of Invertebrates,' by Drs. E. Korschelt, K. Heider, and the second part of the translation of Professor Van Zittel's text-book of paleontology.

BOOKS RECEIVED.

Liquefaction of Gases. Willet L. Hardin, New York and London. 1899. Pp. viii + 250. $1.50.

The Kinetic Theory of Gases. H. S. Burbury, Cambridge. At the University Press. 1899. Pp. viii + 157.

The History of the European Fauna. R. F. Scharff, London, Walter Scott, Ltd. 1899. Pp. 364.

Untersuchungen über die Vermehrung der Laubmoose durch Brutorgane und Stecklinge. Carl Correns, Jena, Fisher. 1899. Pp. xxiv + 472. 15 Marks.

Annuario publicado pelo observatorio do Reio de Janeiro, 1899. Rio de Janeiro. L. Malafaia, Jr. 1899. Pp. x + 318.

Das Tierreich. 5 Lieferung, *Sporozoa.* Alphonse Labbé. Berlin, Friedländer. 1899. Pp. xx + 180. Subscription price, 8.80 Mark. Single 12 Mark.

Catalogus Mammalium tam Owentum quam fossilium. E. L. Trouessart. Fasciculus VI. Index, alphabeticus, Berolini, Fiiedländer. 1899. Pp. 1265–1469.

Electric Motive Power. Albion T. Snell. New York, D. Van Nostrand; London, The Electrician Printing and Publishing Co., Ltd. 2d Edition. Pp. vi + 403. $5.00.

Methods of Knowledge. Walter Smith, New York and London, The Macmillan Company. 1899. Pp. xxii+340.

Hand-book of Optics. William Norwood Suter, New York and London, The Macmillan Company. 1899. Pp. viii+209. $1.00.

Inorganic Chemical Preparations. Felix Lengfeld. New York, The Macmillan Company. 1899. Pp. xviii+55.

Naturæ Novitates. Berlin, Fredländer. 1898. Pp. 780. 4 Mark.

The University Geological Survey of Kansas, Vol. V. Special Report on Gypsum and Gypsum Cement Plasters. G. P. Grimsley and E. H. S. Bailey, Topeka, J. S. Park. 1899. Pp. 83.

Mineral Resources of Kansas. Erasmus Haworth, Lawrence, University of Kansas. 1899. Pp. 128.

Sextus Empiricus and Greek Scepticism. Mary Mills Patrick. Cambridge, Deighton, Bell & Co.; London, George Bell & Sons. 1899. Pp. viii + 163.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, August. 'On Nitromalonic Aldehyde': By H. B. Hill and J. Torrey, Jr. 'Contributions to the Study of Aqueous Solutions of Double Salts': By H. C. Jones and N. Knight. The evidence is in favor of the view that the double chlorides exist as such in concentrated solutions and are only dissociated at great dilution. 'On the Rearrangement of the Thiocarbamic Esters:' By H. L. Wheeler and B. Barnes. 'Dimethyldianthracene, A Polymeric Modification of β-Methylanthracene': By W. R. Orndorff and H. A. Megraw. 'The Action of Chromic Acid on Hydrogen': By C. L. Reese. Experiments carried out under various conditions and temperatures showed that hydrogen is oxidized only very slightly, if at all, below a temperature of 100°. 'Action of Sulphuric Acid on Nitroheptane': By R. A. Worstall.

J. E. G.

The *National Geographical Magazine* for September contains the following articles:

The Commercial Development of Japan, by O. P. Austin.

Bad Lands of South Dakota, by N. H. Darton.

The West Indian Hurricane of August 7–14, 1899, by E. B. Garriott.

The Return of Wellman, by J. Howard Gore.

The International Cloud Work of the Weather Bureau, by Frank H. Bigelow.

The number also contains several shorter articles, as 'The Rediscovery of Porto Rico,' 'Through Franz Josef Land,' and 'The Isthmian Canal Route,' besides a good deal of geographic miscellanea.

DISCUSSION AND CORRESPONDENCE.

NATURALISM AND AGNOSTICISM.

CIRCUMSTANCES, which need not be detailed here, having led me to pay somewhat careful attention to Professor Ward's most skillful 'Gifford Lectures,' I read Professor Brooks' review (SCIENCE, September 1st) of this work with keen interest. The notice cannot be termed unfair, unless, indeed, one take exception to the superfluous statement, "nothing is easier than for one who is not a naturalist to improve upon the work of Charles Darwin." Nothing in Ward's attitude, except, possibly, his tremendous castigation of Spencer, warrants such harshness. On the other hand, Brooks' entire outlook is so different, and the position he adopts so far removed from that of his author that there is a real danger lest readers of SCIENCE should tend to misprize a book wrought out, not only with remarkable analytic insight, but also in competent familiarity and sympathy with scientific methods. I cannot find that Brooks anywhere indicates what task precisely Ward attempts; on the contrary, he sometimes blinks the issue. And yet, this may be stated with directness, and without disrespect to the reviewer, which, I need hardly say, is far from my mind.

The advance of science in the eighteenth and nineteenth centuries has gradually crystallized into four theories, not of scientific phenomena, but of the universe as a whole. (1) The Mechanical Theory. This founds on abstract Dynamics, which deals with molar phenomena; on Molecular Mechanics, which is concerned ultimately with ideals of matter; while, latterly, Mechanical Physics has tended, in some hands, to give way before Energetics, which regards all change as either a transference or a transformation of energy. (2) The Theory of Mechanical Evolution, which seeks to trace *back* the phenomena of the universe, as they now are, to an original condition that can be expressed according to purely mathematico-physical formulæ—the theory of Spencer. (3) Biological Evolution as *implied* in the work of Lamarck, C. Darwin and their followers. (4) The Theory of Psychophysical Parallelism, involving Clifford's 'mind-stuff,' the 'double-aspect' theory, the 'conscious automaton' (Huxley) theory and, generally, the view that 'mind' is an epiphenomenon of 'matter.' The task essayed by Ward may be put in the form of the following question: Taking the fundamental conceptions employed by the various exponents of these theories, what can they be shown to involve when subjected to the analyses of Epistemology? In other words, to what conclusions do they lead inevitably, and are these conclusions sufficient to account for all that is actually involved in man's universe? Brooks' hint of dogmatism may be traced to an incomplete acceptance of the fact, fully accepted by Ward, that, for man, there is no universe but man's universe; and here all dogmatism is out of place.

So far as 'simple-minded men of science' are concerned, I think we may admit that Ward has exploded, beyond peradventure, the assorted dogmas peculiar to the first, second and fourth of these theories of the universe. I am by no means sure that he has achieved similar success with the third, possibly because it still remains so fluid, and I have a tolerably strong conviction that his constructive alternative, termed Spiritual Monism, will prove as unsatisfactory to others as to Brooks. At the same time, one must remember that he has stated this in the briefest and, therefore, most tentative fashion.

Brooks' review dwells almost exclusively on the third theory and, consequently, he hardly does justice to Ward's positive achievement; while, further, his difficulty in adapting himself to the epistemological standpoint seems to lead him to attribute to Ward positions which his author is far from holding. The sections of the review dealing with figurative language show this. The former lapse may be omitted as unimportant. The latter calls for some notice. The reason for Brooks' difficulty in envisaging Ward's standpoint comes out plainly in the following statement: "The naturalist agrees with Ward that our conception of the order of nature is not absolute, but contingent or relative, but he is not prepared to assert that it is a hypothesis; for a hypothesis is a mental product, and he does not know whether the contingency is mental or organic." Waiving the question whether there possibly *can* be an *order* of nature distinct from our conception

of it, this statement implies that there is *a* mental and *an* organic sphere, which may be treated as if each stood in isolation from the other. Whether such an idea be compatible with the Theory of Evolution appears very problematical. Be this as it may, the precise problem of Epistemology is just the question, *can* there be any sphere *for man*, in which anything may be regarded as if it were out of relation to mind, or to 'the mental,' using the more abstract language supplied us? Till this has been determined—and many advance valid reasons for concluding that it has been determined in the negative—discussion of 'teleology' and the like is so much beating the air.

But, fortunately, there happens to be far more community between Brooks and Ward than the printed page reveals. That Brooks should be moved to consider Ward's book at all, that he should attack some of the questions so significantly discussed in his brilliant 'Foundations of Zoology,' and that Ward should go entirely to the positive sciences for his materials are right hopeful signs of the times. No doubt Brooks' review bears witness to an appreciable remnant of that estrangement between science and philosophy which was at its height in the sixties and seventies. In the seventeenth and eighteenth centuries Descartes, Spinoza, Leibniz and Kant drew their materials from the sciences as then formulated; and the 'plain historical way' of Locke, and to some extent of Hume, commended itself to the sober methods of scientific inquiry. But at the beginning of the nineteenth century, thanks to the new 'social sense' that arose with Lessing and Herder and Goethe, philosophy forsook its commerce with the natural sciences and sought aid from the so-called human sciences, especially in those aspects which may be lumped under the name *Culturgeschichte*. This movement reached its zenith with Hegel and his followers. Meanwhile, the natural sciences, particularly in that development of them which Brooks ornaments, had themselves taken up and projected along new lines the very suggestions of the *Culturgeschichte* group, and had summed the results in the term Evolution. This term, as we now understand it, is no more than half a century old, a brief period in the life of any great operative conception, and we are far from clearly perceiving all it implies. "There is 'something more' at work," as Romanes said to me time and again. Ward's book is a product of this conviction of ignorance, so is Brooks' review. Further, the book must be taken as a powerful witness to the return of philosophy to the old, amicable relationship of the seventeenth and eighteenth centuries. The pressing affair of philosophy is to elicit the implications of theories which are not simply provisional groupings of phenomena scientifically observed, but profess to be *Weltansichten*. Just because they are at once scientific and philosophical, neither the scientist nor the philosopher can deal with them in his own corner. Brooks and Ward are at one in proving this. Indeed, the most interesting—some would say the most promising—factor in contemporary intellectual activity crops out in the fact that scientists are becoming more and more alive to philosophical problems, while philosophers are beginning to discover that, after all, their main concern is with the fundamental conceptions incident to that highly organized portion of human experience which goes by the name of science. Each side will better the prospect for a more thoroughly rational explanation of things known and to know by foregoing its own *idola*.

I should not have ventured to intrude at this 'great assize' but for the fact that Brooks attributes to Ward *idola* from which the Cambridge epistemologist has shaken free. On the other hand, and far more important, Brooks himself has already escaped many others which, in the not very distant past, generated that amazing hybrid—a mechanical biology.

R. M. Wenley.
University of Michigan.

THE ORIGIN OF MEASUREMENTS.

To the Editor of Science: My small boy, aged 5 years, was discovered this summer to have originated a system of measurement which he used in conversation with other children. Certain distances were described as four men, and certain other distances were spoken of as a boy or half a boy. Certain others were spoken of as two men and a boy. Perhaps this may

be of interest in connection with the origin of measurements by the foot, the span, the hairs-breadth, etc.

H. H. CLAYTON.

BLUE HILL, MASS., September 5, 1899.

THE FAUNA OF PORTO RICO.

TO THE EDITOR OF SCIENCE: It is somewhat surprising to find in the current number of SCIENCE (Sept. 1, p. 286), a paper by Dr. Mark W. Harrington on the 'Fauna and Flora of Puerto Rico,' which shows the writer to have, in some respects, less knowledge of West Indian mammal and bird life than was possessed by the discoverer of these islands. Columbus, in his journals, comments on the absence of large animals in the islands which he visited and states that the only land mammal found was the Hutia, or Utia, on which he was feasted by the natives of the Bahamas, Hayti and San Domingo, and Cuba. In the last named island the animal is still common under this name,* three species being known, viz., *Capromys pilorides*, *C. melanurus*, and *C. prehensilis*. The remaining members of the genus are *Capromys brachyurus*, of Jamaica, now supposed to be on the verge of extinction, largely through the ravages of the Mongoose; *C. thoracatus*, a nearly allied form discovered by Townsend in Swan Island, and the remarkably distinct *C. ingrahami*, described by Allen from the Plana Keys, Bahamas, in 1891, when for first time Columbus' mention of the Utia in the Bahamas was given a scientific status. In Hayti and San Domingo there occurs a member of the same Histricomorphine family (Octotontidæ), *Plagiodonti aædium*, an exceedingly rare animal of which little is known, and this, with the six species of *Capromys* named, two species of *Solendon*—one each from Cuba and Hayti—and a small species of *Oryzomys* from Jamaica, constitutes the entire known indigenous terrestial mammalian fauna of the Greater Antilles; there being, therefore, no indigenous land mammal recorded from Porto Rico. For this reason it is with no small interest we find your correspondent saying of the 'wild fauna' of Porto Rico: "Generally speaking, the largest wild mammal is a ground squirrel, about the size of a gopher. A few others of larger size are reported from time to time, but they are only occasional and are probably animals escaped from cultivation. Probably the larger animals once existed, and their traces could doubtless be found by a linguist in the place names which abound all over the island and are quite often not Spanish * * *."

*In Hill's recently published 'Cuba and Porto Rico' (p. 55), this animal is miscalled 'Agouti.' Only one species is said to occur in Cuba, and the creature is stated to be found in the Windward Islands, but not in Jamaica, whereas the reverse is true. There is, however, in the Windward Islands a true Agouti (*Dasyprocta cristata*), the only member of the genus occurring in the West Indies.

The 'squirrel' mentioned is as yet unknown to students of the Greater Antillean fauna, who have also failed to discover, either in the records of man or nature, any evidence of the former existence of large mammals in these islands.

In respect to birds, it appears that both your correspondent and Columbus found 'Nightingales' in the West Indies; an error as pardonable 400 years ago as it is inexcusable to-day.

FRANK M. CHAPMAN.

AMERICAN MUSEUM OF NATURAL HISTORY, September 7, 1899.

METHODS FOR A CARD INDEX.

IN the last number of SCIENCE Professor Porter, of the Harvard Medical School, outlines a plan for a card *Centralblatt* of physiology, which when carried into effect will greatly smooth the way for students of physiology and related sciences. I am not, however, sure that the plan proposed is the most practicable. A card index is without doubt the most convenient form of an index, chiefly because it can be continually and homogeneously increased. It is, however, bulky and somewhat inconvenient to use, and hence, I think, not suited for the publication of abstracts, especially when they extend beyond the limits of a single card. The most convenient and economical method of storing printed matter is in the form of books on a shelf. The card catalogue should be an index to these books.

There should be for each of the sciences *Centralblätter* or series of abstracts and probably one in each leading country so as to secure

completeness and different perspectives. Then there should be a central bureau as planned by the Royal Society, which would send out promptly a card catalogue giving all the titles and also references to reviews and abstracts (at least in certain standard journals), as they appear. The slips giving data regarding reviews and abstracts would, of course, refer to the article abstracted, and should, perhaps, be printed on narrow and thin slips which could be pasted on the original cards. If the abstracts in question are by competent men of science, it would be an advantage if an opinion were expressed in regard to the importance of the work reviewed, whether it is a compilation or an original research, etc. If this were done by some uniform system it could be carried over to the slip by a symbol, as a letter or a single word.

We are undertaking to carry out this plan for psychology in the Psychological Laboratory of Columbia University, but it has, of course, only local usefulness so long as the Index is not published. We have a card catalogue of psychological literature, and the card indicates whether the publication can be found in the University Library and if not the most accessible library in which it can be found. It is proposed to add references to abstracts and reviews, as far at least as they are contained in the *Zeitschrift für Psychologie* and the *Psychological Review*, and to indicate the character and value of the publication. To learn the contents it is only necessary to turn to a journal within arm's reach.

J. McKeen Cattell.

Columbia University.

NOTES ON INORGANIC CHEMISTRY.

The investigations of Professor K. A. Hofmann have shown the decided analogies which exist between hydroxylamin NH_2OH and water especially in possessing both a basic and an acidic nature. The basic nature lies in the tendency of the amido group to form an ammonium group, while the acidic nature rests in the hydroxyl group, in which the hydrogen atom is in derivatives replaceable by a metal. A new analogy between hydroxylamin and water is now shown by Rudolf Uhlenhuth in Liebig's *Annalen.* When hydroxylamin is added to a concentrated solution of nickel sulfate, a red crystalline precipitate is formed, which has the formula $NiSO_4$, $6NH_2OH$. This would be ordinarily considered hydroxylamin of crystallization. Nickel sulfate, however, crystallizes as many other vitriols with $7H_2O$. According to Werner's hypothesis one of these water molecules is united chemically with the SO_4, while the other six are coördinated with the nickel atom. Now the hydroxylamin could not be thus united with the SO_4, hence we find only six molecules present. This would seem to add another to the not long list of substances such as water, ammonia, etc., which can be coördinated with the metallic atoms.

Practical use is being made of the high temperature developed by the reduction of metallic oxids by aluminum, as described by H. Goldschmidt in the *Zeitschrift für Electrochemie.* Carbon-free metals are readily obtained, as chromium for chrome steel and manganese for manganese bronze. Vanadium oxid is reduced by aluminum only to the suboxid V_2O, but columbium oxid is reduced to the metal. As a by-product in these reactions an artificial corundum is obtained which surpasses the natural emery as an abrasive. When a mixture of iron oxid and aluminum reacts, the temperature is intense but is very circumscribed, so that it can be used for many purposes, such as welding steel, where a high temperature is desired locally.

A contribution to the chemistry of matches has appeared in the *Bollettino chimico-farmaceutico* by Giovanni Craveri of Buenos Ayres. He suggests the replacement of phosphorus in matches by perthiocyanic acid $H_2C_2N_2S_3$, and claims that such matches are not poisonous nor explosive, strike on any surface and burn brightly. Perthiocyanic acid can be readily made from the by-products of several processes, such as the purification of coal gas or the Lebane soda manufacture, and already its cost is less than that of phosphorus. If the new matches prove all that is claimed for them, Craveri will be recognized as a benefactor of the human race.

The paper by Sir William Crookes on victorium, a new element associated with yttrium, recently read before the Royal Society has been

printed in full in the *Chemical News.* The discovery of the element, to which at first the name monium was given, resulted from photographic researches on phosphorescent spectra, it giving a very characteristic group of lines in the ultra-violet. The concentration of victorium is accomplished first by the fractional decomposition of the mixed nitrates of the yttrium metals by heat. The nitrates of the earths of the cerium group decompose more readily, and those of the yttrium group less readily than that of victoria, so that after a large number of fractionations the victoria collects in the middle portions. These middle fractions are then submitted to fractional precipitation with oxalic acid, many times repeated, and finally the portions richest in victoria are converted into sulfates and fractionally precipitated with potassium sulfate. In the purest condition thus far obtained, victoria is a pale brown powder, less basic than yttria and more basic than most of the oxids of the terbia group. Assuming the oxide to be Vc_2O_3, the atomic weight of victorium is about 117. The most marked characteristic of victoria is its spectrum.

J. L. H.

ZOOLOGICAL NOTES.

IN the annals of the South African Museum, Mr. L. Péringuey describes a method, discovered by Rev. J. A. O'Neil, for capturing both sexes of the members of the hymenopterous genus *Mutilla.* By seizing the female in such a way as to induce her to produce her well-known stridulation, the males immediately appear and are easily secured, at times even settling on the hand of the captor. As the sexes are certainly known in but 16 out of the 169 South African species, the practice of this 'sembling' method, as it is styled, is to be recommended.

THE report of the Australian Museum for 1897 records the mounting of a specimen of the Galapagos tortoise *Testudo nigrita* brought to Sydney, New South Wales, by the American whaler *Winslow*, in 1853. At that time it weighed 53 pounds, while at the time of its death, in 1896, its weight had increased to 368 pounds, a more rapid rate of growth than such animals are usually credited with.

ACCORDING to Mr. Etheridge of the Colombo, Ceylon, Museum, by far the largest cobra ever recorded is one measuring 7 feet 9 inches taken at Jaffna, but as the measurement was made on a skin, it is possible that the maximum length attained by this deadly snake is not far from 7 feet 6 inches.

MR. ETHERIDGE discusses the use of formol at some length, stating that its great fault is its bleaching property, and that pure glycerine can alone be trusted to keep color, because it excludes those great destroyers of animal colors, air and water. Formol in combination with various salts will preserve color for a greater or less length of time, but not permanently. Thus a three per cent. solution of formol, saturated with common salt, preserved the color of *Oreastes turitus* for about eighteen months, and then the specimen faded completely in a few days. Epsom salt in combination has the curious property of keeping the fugitive blues, greens and violets of the wrasses for at least a year, although destructive to the colors of other fishes.

IT will doubtless surprise many to be told that the mastodon is far more common in American museums than is the African elephant. The skeleton of Jumbo in the Am. Mus. Nat. Hist., New York City, is almost the only specimen of this animal in the country, while there are at least ten mounted skeletons of mastodon and teeth and bones without number. It is not too much to say that not a week elapses without some published account of the discovery of mastodon remains and while most of the specimens are poorly preserved, or consist only of individual teeth, yet in the aggregate their number is very considerable. Orange and Ulster counties, N. Y., appear to have been favorite burying places for the mastodon, and from the character of the ground it is evident that many specimens will yet come to light from these localities.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

THE Astronomical and Astrophysical Society of America, which, as we have already stated, was recently established at the third Conference of Astronomers and Astrophysicists held at the

Yerkes Observatory, has elected officers as follows:

President, Simon Newcomb; Vice-Presidents, C. A. Young, George E. Hale; Treasurer, C. L. Doolittle; Councillors for two years, E. C. Pickering, J. E. Keeler; Councillors for one year, E. W. Morley, Ormond Stone; Secretary for three years, George C. Comstock.

We hope to publish in an early issue a full report of the meeting at the Yerkes Observatory together with abstracts of the papers presented.

It is expected that the New York Zoological Park will be formally opened to the public during the second week in October. Only a few of the buildings will be completed, but there is already a fairly representative collection of animals in the Park.

The United States Fish Commission steamer *Albatross* sailed from San Francisco on August 23d, with a scientific party under Professor Agassiz bound for the South Pacific. The objects, itinerary, and personnel of the expedition were noticed in the issue of Science for June 9. The voyage will occupy eight or nine months, and is expected to yield much valuable information pertaining to the fauna of the little-known regions that will be visited.

During the present season the U. S. Fish Commission has had a number of field parties, in various States, engaged in ichthyological and other investigations. A camping party under the direction of Dr. Charles H. Gilbert has systematically examined the coastal streams of Oregon, with reference to their fish fauna; the eastern tributaries of the Sacramento have been visited by Mr. Cloudsley Rutter; a comprehensive study of the biological and physical features of the Wabash basin has been begun under the direction of Professor B. W. Evermann, who is assisted by Dr. J. T. Scovell, Dr. C. H. Eigenmann and others; a party in charge Mr. W. P. Hay has explored the Monongahela basin in West Virginia; Dr. P. H. Kirsch has been collecting and studying the fishes of the San Pedro River, Arizona; in connection with the biological survey of Lake Erie, Professor Jacob Reighard and assistants have cruised along the northern and southern shores of the lake in a special steamer; Dr. H. M. Smith has visited Seneca Lake, N. Y., for the purpose of determining the character of its fish fauna; a study of the variations of the mackerel of the east coast has been conducted by Mr. M. C. Marsh, and in the interesting Sebago and Cobbosseecontee lake regions of Maine, Dr. W. C. Kendall has made some special investigations regarding salmon and other fishes.

We regret to learn that Professor E. W. Hilgard, of the University of California, and Director of the California Agricultural Experiment Station, has been seriously ill during the summer. It is feared that he will not be able to resume his duties at the beginning of the academic year.

Mr. W. T. Swingle, agricultural explorer for the Department of Agriculture, has returned from an extended trip to the Mediterranean countries, undertaken for the Department, with the view of finding new agricultural industries capable of being introduced into the United States. He made a special study of viticulture and of the date and fig industries, and for some months will be at Washington, engaged in preparing for publication the results of his trip.

Professor G. S. Fullerton, who holds the chair of philosophy at the University of Pennsylvania, has returned to Philadelphia after a year's absence in Europe.

Professor C. H. Hitchcock, of Dartmouth College, will resume his work this month after a year's leave of absence spent in Australia and Hawaii where he has been carrying on geological work.

Dr. Thurston, of Cornell University, has been requested to serve on a number of the Congresses, to be held in connection with the Paris Exposition, including those for mining, metallurgy, testing materials of construction and applied mechanics. He has been appointed a member of the *Comité de patronage*, and has been invited to prepare the reports on 'Mechanical Laboratories,' as *rapporteur* or editor and the introductory paper. He particularly desires full accounts of all laboratories of that character in the United States. Men of science, interested in the subject, either through their

connection with the physical sciences, pure or applied, or as engineers interested in research in these departments, who wish to join this Congress may apply either to Dr. Thurston or to the Secretary of the American Society of Mechanical Engineers for circulars giving the form of organization and a statement of the questions to be discussed, as well as for cards of 'adherence' to the several divisions of this Congress.

DR. R. BURCKHARDT, professor of paleontology at Bâsle, and Dr. V. Uhlig, professor of geology in the German Technical Institute of Prague, have been elected members of the academy of sciences at Halle.

THE Physiological Institute of the University of Berlin, has been presented, by his widow, with a marble bust of Emil Dubois-Reymond.

AMBROSE P. S. STUART died at his residence in Lincoln, Nebraska, September 13, 1899. He was born November 22, 1820, in Sterling, Worcester county, Mass. He graduated from Brown University in 1847, with the degree of A.B., and spent three years subsequently at Heidelberg. He taught school for a number of years, and in 1865 became instructor in chemistry in the Lawrence Scientific School of Harvard University. Later he was professor of chemistry in the Pennsylvania State College, and still later in the University of Illinois. He removed to Lincoln, Nebraska, in 1875, where he engaged in business, amassing a considerable fortune. Throughout his life he maintained his interest in scientific matters, and despite his advancing years was a familiar figure in the meetings of scientific societies.

THERE will be, on October 17th, civil service examinations for the position of nautical expert in the Hydrographic Office of the Navy Depart with a salary of $1000, and for the position of ornithological clerk in the division of Biological Survey, Department of Agriculture, with a salary of $660. Candidates for the latter position should be between 20 and 25 years of age.

THE late Richard B. Westbrook of Philadelphia has made a bequest of $10,000, taking effect on the death of his widow, to the Wagner Institute of Science. The sum is to be used as an endowment of a special lectureship to "secure the full and fearless discussion by the most learned and distinguished men and women in our own and other countries of mooted or disputed questions in science, and especially the theories of evolution."

MR. ANDREW CARNEGIE has given $50,000 to the City of Oakland, Cal., the city having undertaken to guarantee at least $4,000 annually for its support.

THE schooner *Julia E. Whalen*, Captain Noyes, has arrived from a cruise to the Galápagos Islands and to Cocos and Clipperton Island west of Ecuador. The vessel had not touched any inland port since she sailed from San Francisco, October 30th, last. She carried members of a scientific expedition under direction of Robert E. Snodgrass, assistant in entomology and Edmund Heller, student in zoölogy, sent by Stanford University, under the patronage of Timothy Hopkins, of San Francisco. A large collection of specimens, including birds, mammals, invertebrates, and fish, was obtained. Aboard the vessel were eighteen live land tortoises taken from Duncan and Albemarle Islands, some of them weighing four hundred pounds; also 220 fur sealskins and 2,300 skins of hair seals.

A CABLEGRAM states that the British Association for the Advancement of Science at its present meeting has granted £1,000 toward the expenses of the British antarctic expedition.

THE steamer *Antarctic*, which left Helsingborg, Sweden, on May 25th last with an expedition under Professor A. G. Nathorst, was spoken off The Skaw, the northern extremity of Jutland, Denmark, on the 11th ult., on her return from her search along the northeast coast of Greenland for Andrée. No traces of the missing æronaut had been found.

INFORMATION has been received from the captain of the icebreaker *Ermack*, arrived in the Tyne, to the effect that he met the Prince of Monaco's yacht *Princess Alice* on August 21st, in Advent Bay, Spitzbergen. The yacht had been aground six days in the Red Bay, and after discharging 200 tons of coal and stores was floated. There is no leakage, but the vessel has received some small damage.

THE death has taken place at Leith of Mr.

John Ramsay, one of the survivors of the expedition sent out to search for Sir John Franklin. He joined the Navy in 1849, and formed one of the crew of the *Resolute*, which sailed from Woolwich in 1852.

On the 20th of August last an International Conference met at Berne to study the glaciers of the Rhone and Aar, to which extended excursions were made. Among those present were Professors Penck of Vienna, Reid of the Johns Hopkins University, von Drygalski of Berlin, Fürsterwalder of Munich, Baron von Toll of St. Petersburg, and other students of glaciers.

The Intercolonial Medical Congress of Australasia will hold its fifth session in Brisbane from September 18th to 23d.

The tenth congress of Italian Alienists will be held in Naples from the 10th to the 14th of October, under the presidency of Professor Tamburini. We learn from the *British Medical Journal* that the following are the subjects proposed for discussion: Practical methods of individual psychological investigation in asylums and clinics; the light which has been, and may be, thrown by anatomical data on normal and pathological psychology; psychiatry and the study of the individual and his activity in social relations; intoxications and infections in the pathogenesis of mental diseases and neuropathies.

The German Government has sent Professor Kossel, of the Board of Health, to Lisbon and Oporto to study the plague and the methods adopted to combat it. He is accompanied by Professor Frosch, of the Berlin Institute for the Study of Infectious Diseases, who is being despatched on the same mission by the Prussian Government.

UNIVERSITY AND EDUCATIONAL NEWS.

The Rose Polytechnic Institute will shortly receive \$50,000 from a bequest of the late Joseph Collett, the payment of which has been delayed through litigation.

It is reported that the German technical schools will be authorized to confer the degree *Doctor rerum technicarum*, and that the degree will be conferred for the first time on the occasion of the celebration of the centenary of the Charlottenburg Technical School.

The Regents of the University of Texas have provided a psychological laboratory which has been placed under the charge of Professor Caswell Ellis, of the department of pedagogy.

At the University of West Virginia the following appointments have been made: Edward D. Copeland, A.B. (Stanford), Ph.D. (Halle), lately assistant professor of botany at Indiana University, to be assistant professor of botany; J. B. Johnston, Ph.D. (Michigan), to be assistant professor of zoology; Otto Folin, B.S. (Minnesota), Ph. D. (Chicago), to be assistant professor of chemistry, and J. D. Thompson, M.A. (Cambridge) of Trinity College, Cambridge, and University College, Sheffield, to be assistant professor of mathematics.

At the Ohio State University, W. E. Henderson has been appointed assistant professor of analytical chemistry and C. B. Morrey, assistant professor of anatomy and physiology.

A. Kirschmann, Ph.D., lecturer in philosophy at the University of Toronto since 1894, has been appointed professor of philosophy and director of the psychological laboratory.

Professor Richard Pfeiffer has been called from the Berlin Institute for infectious diseases to the University of Königsberg as successor to Professor von Esmarch.

It is reported that Dr. Arons, Privat-Docent for physics in the University of Berlin, has been called to a chair of physics at Würzburg. It will be remembered that Dr. Arons has been prosecuted by the Government for being a socialist, but that the philosophical faculty of the University of Berlin refused to take any action disciplining him.

Rollo Kent Beattie, B.Sc., 1896 and A.M., 1898, of the University of Nebraska, has been elected to the instructorship in botany in the Agricultural College at Pullman, Washington, and John Lewis Sheldon, B.Sc. (Nebraska), recently appointed assistant in botany in the same university, has accepted the instructorship in biology in the Nebraska State Normal School.

PEIRCE ON THE PERCEPTION OF HORIZONTAL AND OF VERTICAL LINES.

SCIENCE

FRIDAY, SEPTEMBER 29, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PERCEPTION OF HORIZONTAL AND OF VERTICAL LINES.

ALMOST every person is occasionally called on to decide 'by the eye' whether some straight line is horizontal or some other line vertical. It usually happens, as, for instance, when one has to set a picture straight on the wall of a room, that the judgment is helped by the presence, in the neighborhood, of other lines, known to be nearly horizontal or vertical, but sometimes all standards are lacking and then the decision is a little more difficult to make.

In order to find out whether such training as a student of physics gets from several years of laboratory work is likely to improve his judgment in such matters as these, and whether astigmatism affects the results materially, I have experimented in the Jefferson Physical Laboratory upon forty persons who kindly consented to make observations for me.

We used two very simple pieces of apparatus. One of these is a fixed horizontal telescope, the eye piece of which can turn freely in its tube. The eye piece carries a single cross hair within, and a large sheet brass disc coaxial with the telescope without. This disc serves as an eye screen, and carries, on the side away from the observer, a divided circle which has a fixed reading microscope. The observer, sitting in a chair before the instrument, with eyes screened from a view of extraneous objects, turns the disc while

looking through the telescope with one eye, until the cross hair, which turns with the disc, seems to be vertical, or horizontal, as the case may be. A piece of ground glass in front of the object glass allows light to have access to the inside of the telescope, but keeps out all disturbing images. An assistant then reads off on the scale, and records, the deviation from verticality or horizontality, and a new setting is made. The mean of a dozen settings, ranging in the cases of some persons over as much as two degrees, suffices to show whether the observer has a decided bias and to measure it fairly well, if it exists. The subjoined table (I) gives the results of the observations of ten persons, five of whom are instructors in Harvard University. The last observer in the list is a lady. The first two and the seventh observers are astigmatic. The first two columns give in degrees the means of the deviations from level of a number of horizontal settings of the cross hair made with the left eye and the right eye respectively. The next two columns give corresponding means of vertical settings. In all the cases the positive sign implies a rotation from the correct position in clockwise direction. The horizontal determinations of all the observers except one, illustrate a fact, familiar to some astronomers and physicists, that a cross hair which seems level to the right eye of a person generally needs to be rotated slightly in counter-clockwise direction to suit the left eye. The third line of the third column shows the only large bias that I have found. In a large number of cases, as the table shows, the deviation of the mean was practically nothing. When the ground glass in front of the object glass was removed, a plumb line made of silk fibre appeared in the field of the telescope, and many settings have been made, by different persons who have used this apparatus, which could not be in the least improved when the plumb line became visible. Observations made by the same person on different days show slight differences in general, but unusual fatigue sometimes introduces a temporary bias of half a degree or perhaps a little more. I have not been able to discover from settings made with unscreened eyes in a room in which many horizontal and vertical lines may be seen, that observers are much affected by after images, or by outside standards not nearly superposed upon the line to be set, provided that the head is erect.

TABLE I.

Observer.	Mean deviation of horizontal settings made with		Mean deviation of vertical settings made with	
	the left eye.	the right eye.	the left eye.	the righ eye.
1	+0°.6	+1°.2	—2°.3	+0°.2
2	+0 .1	—0 .9	—0 .2	—1 .4
3	—1 .5	+0 .8	—5 .2	—0 .5
4	—0 .2	+0 .6	±0 .0	+0 .6
5	+0 .1	+0 .8	±0 .0	+0 .8
6	—0 .6	+0 .6	—0 .2	+0 .1
7	—0 .1	+0 .8	+0 .4	+0 .5
8	—0 .2	+0 .7	—0 .2	—0 .1
9	±0 .0	+0 .4	—0 .2	—0 .3
10	—0 .7	±0 .0	±0 .0	±0 .0

To find out whether the accuracy of the results depended mainly upon the horizontality of the seat occupied by the observer, a long series of settings were made by a person who sat in a chair which rested upon a platform inclined about 5°, first towards the left and then towards the right. The feet of the observer were placed upon the rungs of the chair. The exact agreement of the deviations, as shown in the following table (II) is, of course, accidental, but it is clear that the inclination of the seat did not appreciably affect the judgment of this person.

TABLE II.

Seat inclined to the left.				Seat inclined to the right.			
Horizontal settings.		Vertical settings.		Horizontal settings.		Vertical setings.	
Left eye.	Right eye.	Left eye.	Right eye.	Left eye.	Right eye.	Left eye.	Right eye.
—0°.3	+0°.7	+0°.5	+0°.7	—0°.3	+0°.7	+0°.5	+0°.7

If, while a person is sittting or standing, the head be much inclined, the deviations of the settings of the cross hair become much greater than when the head is erect. The apparently horizontal and the apparently vertical lines seem always to be turned out of their true position in clockwise direction when the head is inclined to the right, and in counter-clockwise direction when the head is turned to the left.

At the suggestion of Professor C. E. St. John, some settings were made while the observer lay on a horizontal raised board with head supported so that the line joining the eyes was vertical. In this case the deviations were enormous, as may be seen in the results given in Table III. It will be observed that the apparently horizontal and vertical lines were in all cases turned from their true positions, in clockwise direction if the observer was lying on his right side, and in counter-clockwise direction if he was lying on his left side. If, after a setting had been made, the observer looked away from the instrument and at the walls of the room for a little while and then back again into the telescope, the deviation seemed enormous at first, but it decreased rapidly and continuously, and at the end of, perhaps, ten seconds the setting seemed again good. While making these observations the eyes were carefully screened.

The observers were those denoted by the same numbers in Table I.

The second piece of apparatus is represented, though without its screen, in the accompanying figure. The observer, looking through a horizontal tube about 35 centimeters in diameter and 2 meters long, which shuts out of sight extraneous objects and is blackened inside and furnished with several diaphragms to prevent reflection from the inner surface, sees a white circular field 35 centimeters in diameter, divided into halves by a fine, straight, black ink line. This field is the central portion of a large piece of smooth cardboard, mounted on a wooden disc, 75 centimeters in diameter. The disc is in a vertical plane perpendicular to the line of sight, and can be turned about a horizontal axis in the geometrical axis (produced) of the observing tube. By the use of simple mechanism the observer may rotate the disc until the line on the cardboard seems to him horizontal or vertical. Its deviation from true horizontality or verticality can then be read off, to a hundredth of a degree if such accuracy is ever desirable, by an assistant with the help of a microscope and scale on the back of the disc.

While using this apparatus the observer can stand on a platform of proper height, level or inclined, or he may sit on a high chair. In any case his eyes must be properly screened* so that he cannot see any outside objects. The apparatus is furnished with a large metal screen not shown in the illustration.

TABLE III.

Observer.	Mean of horizontal settings made while lying on the				Mean of vertical settings made while lying on the			
	left side,		right side,		left side,		right side,	
	by the left eye.	by therig eye.	bythe eye.	by the right eye.	by the left eye.	by the right eye.	by the left eye.	by the right eye.
1	—16°	——	——	+ 9°	—14°	——	——	+20°
4	—10	—11°	+10°	+ 6	— 6	—13°	+ 7°	+ 4
5	—11	——	——	+15	— 7	——	——	+18
8	—22	—13	+11	+17	—22	—15	+19	+14

* In some experiments made recently in the laboratory of Professor Cattell, of Columbia University, the observer was wisely stationed in a perfectly dark room.

TABLE IV.

Observer.	Horizontal Settings. (The readings show deviations from level.) The mean of the set of readings.	The algebraically smallest reading.	The algebraically largest reading.	The "range" of the readings.	The average deviation of the readings from their mean.	Vertical Settings. (The readings show deviations from verticality.) The mean of the set of readings.	The algebraically smallest reading.	The algebraically largest reading.	The "range" of the readings.	The average deviation of the readings from their mean.
1	−1°.19	−1°.48	−0°.85	0°.63	0°.21	−1°.02	−1°.39	−0°.55	0°.84	0°.21
2	−0.16	−1.00	+0.62	1.62	0.32	−0.03	−0.98	+0.64	1.62	0.36
3	−0.44	−1.10	+0.32	1.42	0.32	−0.55	−1.70	+0.28	1.98	0.33
4	−0.10	−1.41	+1.10	2.51	0.48	−1.59	−3.10	−0.50	2.60	0.62
5	+0.26	−0.53	+1.07	1.60	0.33	+1.29	+0.42	+2.36	1.94	0.42
6	−1.22	+2.13	−0.50	1.63	0.32	−0.59	−1.37	+0.05	1.42	0.29
7	−0.44	−0.90	−0.02	0.88	0.25	−0.46	−1.56	+0.42	1.98	0.44
8	−0.81	−1.50	−0.30	1.20	0.24	−0.30	−0.70	+0.06	0.76	0.20
9	−0.38	−1.12	+0.04	1.16	0.24	+0.42	−0.26	+1.08	1.34	0.32
10	±0.00	−0.72	+0.60	1.32	0.26	+0.08	−0.70	+0.95	1.65	0.53
11	+0.56	−0.45	+1.40	1.95	0.33	−0.33	−1.08	+0.38	1.46	0.36
12	−0.11	−1.00	+0.55	1.55	0.37	−0.10	−0.83	+0.67	1.50	0.25
13	−0.23	−1.30	+0.57	1.87	0.39	−0.10	−1.07	+0.83	1.90	0.44
14	−0.01	−0.64	+0.57	1.21	0.24	+0.50	−0.17	+1.48	1.65	0.34
15	+0.01	−0.76	+0.65	1.41	0.27	−0.09	−1.25	+0.70	1.95	0.38
16	+0.17	−2.03	+2.02	4.05	0.01	−1.41	−2.89	+1.62	4.51	0.67
17	+0.42	−0.11	+0.92	1.03	0.23	+0.77	−0.17	+1.61	1.78	0.37
18	+0.81	+0.35	+1.52	1.17	0.27	−0.05	−0.65	+1.30	1.95	0.50
19	+0.28	−0.98	+1.82	2.80	0.69	−0.32	−1.78	+0.77	2.55	0.49
20	−0.16	−0.80	+0.80	1.60	0.27	+0.64	+0.01	+1.48	1.47	0.41
21	+0.18	−0.62	+0.85	1.47	0.29	+0.01	−0.77	+0.76	1.53	0.26
22	−0.04	−0.64	+0.43	1.07	0.17	+0.02	−0.30	+0.44	0.74	0.18
23	+0.19	−0.60	+0.86	1.46	0.33	+0.33	−0.62	+1.15	1.77	0.49
24	+0.04	−1.43	+1.60	3.03	0.65	−0.67	−2.27	+1.44	3.71	0.67
25	−0.86	−3.71	+1.87	5.58	1.39	−0.81	−4.01	+4.05	8.09	0.75
26	−0.45	−2.52	+1.81	4.33	0.71	−1.55	−3.40	−0.37	3.03	0.61
27	+1.16	+0.65	+1.56	0.91	0.16	+0.97	+0.68	+1.35	0.67	0.13
28	+0.39	+0.01	+0.79	0.78	0.20	−0.07	−0.52	+0.35	0.87	0.16
29	−0.38	−1.60	+0.50	2.10	0.58	−0.59	−1.19	+0.20	1.39	0.36

With this apparatus many hundreds of settings were made. Table IV. contains the results of a large number of these made by 29 different persons, each one of whom, while making his long set of observations, stood at ease in front of the tube and, using both eyes, attempted to set the line correctly. All the angles are here given, as they were first read, to hundredths of a degree, but it is evident that the last figure is generally nearly meaningless. Of these 29 persons, two (Nos. 25 and 26) are boys 10 and 8 years old, respectively, and No. 16 is a somewhat older boy. Nos. 23 and 24 are young girls. The ranges of four of these five children are noticeably large. No. 21 is a lady. Thirteen of the other observers, all of whom are men, are either instructors in Harvard University, or other members of the staff of the Jefferson Physical Laboratory. It should be said that a given number may represent different observers in the different tables.

Eleven of the twenty-nine subjects were known to be astigmatic. Most of these could see very imperfectly without eyeglasses, and yet they could set the line about as accurately without these glasses as with them. For instance, the means of horizontal and vertical settings made by observer No. 13 without his spectacles, were — 0°.20 and + 0°.02 respectively. There does not seem to be any obvious connection between the directions of the principal axis of the eyes of an astigmatic observer and the bias shown by his observations.

The average range of the 24 adult persons represented in the Table is 1°.45 for horizontal settings and 1°.56 for vertical settings. The corresponding ranges of so many of these persons as were distinctly astigmatic were 1°.48 and 1°.56 respectively. The average deviation of the horizontal settings of the astigmatic adults is 0°.46 and of the other adults 0°.35. The corresponding average deviations of the vertical settings were 0°.32 and 0°.54. I have partial records for a good many other persons but the numbers given in the Table are fairly representative.

Taking into account all the results, and calling the mean of a great number of readings of settings made by any person, his 'deviation,' we may say, that persons entirely untrained in making measurements, generally set the line rather carelessly, as children do, and have large ranges, though their deviations are not especially large. Trained observers have smaller ranges than other people, but their deviations are not noticeably small. Astigmatism, so severe as to require the constant use of spectacles, does not seem to affect the readings much. Only one person in ten is likely to have a deviation as great as 1° for horizontal settings, while one person in five may be expected to have a deviation of 1° or more for vertical settings. A deviation as great as 1°.6 is very unusual, but many persons may be found whose deviations both from horizontality and verticality are less than 0°.1. The average deviation is about 0°.4 for horizontal settings, and about 0°.5 for vertical settings.

If the platform upon which the observer stands be inclined (sidewise) to the horizon, he becomes ill at ease and his deviations are generally altered. Whether the platform is tipped downward towards the left or towards the right, however, seems in many cases not to affect the signs of the new deviations, which are sometimes, if not usually, mere exaggerations of those obtained when the platform is level. A certain skillful mechanician, for instance, had deviations from horizontality and verticality of + 0°.5 and − 0°.8, respectively, with platform inclined 5° downward to the right, and corresponding deviations of +0°.6 and − 0°.6 with platform inclined to the left. His horizontal and vertical deviations when the platform was level, were positive and negative respectively, but not greater than 0°.1 in either case.

If the observer stood on a level platform, squarely facing in a direction at right angles to the axis of the tube, and then looked over his shoulder, using both eyes and turning only the head and neck, he was still able to set the line horizontal or vertical with some accuracy. The horizontal deviations of two observers while standing in the way just described and looking over their right shoulders were ± 0°.0 and − 1°.0. Their vertical deviations were − 0°.2 and − 1°.0.

Table V. gives the results of some settings taken when the observer, using only one eye, stood at his ease in front of his instrument.

TABLE V.

Observer.	Means of horizontal settings made with			Means of vertical settings made with		
	the right eye.	the left eye.	both eyes	the left eye.	the right eye.	both eyes.
1	−0°.4	−0°.1	±0°.0	±0°.0	−0°.1	±0°.0
2	+1 .4	−0 .7	+1 .4	+1 .3	+0 .2	+0 .8
3	+0 .1	+0 .8	±0 .0	−0 .4	±0 .0	+0 .1

It should be said that the first two of these observers when asked to point quickly at a distant object, always indicate a line passing midway between the eyes, and not a line passing through one eye, as many people do.

Two persons successively took observations by standing on a shelf with back squarely turned to the tube and trying to set the line horizontal while looking backwards between the legs with head inverted.

The deviation of one of these persons was $-1°.4$. The settings of the other were always positive when made from the positive side and negative when made from the negative side. The average deviation of a single setting made by this person was in absolute amount $1°.5$.

When settings are made by a person while standing squarely before the instrument with his head *much* inclined to one side, the deviations are always clockwise when the inclination is to the right, and counter-clockwise when the inclination is to the left. When the inclination is small it is, of course, not possible to predict the signs of the deviations. The settings of one observer, and of only one among several who were examined, were exceptions to the rule when the head was inclined as much as 20°. In Table VI. the first line gives the deviations of an observer fairly representative of the average, and the second line those of the exceptional person just mentioned. The inclinations were very nearly 20° in all cases.

TABLE VI.

Observer.	Horizontal settings made, when the head was inclined to the						Vertical settings made when the head was inclined to the					
	Left,			Right,			Left,			Right,		
	using the left eye.	using the right eye.	using both eyes.	using the left eye.	using the right eye.	using both eyes.	using the left eye.	using the right eye.	using both eyes.	using the left eye.	using the right eye.	using both eyes.
1	$-2°.3$	$-0°.9$	$-2°.0$	$+2°.1$	$+1°.4$	$+1°.9$	$-1°.9$	$-2°.2$	$-1°.9$	$+0°.7$	$+1°.5$	$+1°.4$
2	$+1\ .3$	$+3\ .4$	$+2\ .1$	$-0\ .6$	$+0\ .9$	$+1\ .4$	$+1\ .1$	$+2\ .2$	$+1\ .2$	$-0\ .6$	$-1\ .0$	$-2\ .4$

When the observer lay on one side on a horizontal shelf, with the line joining his eyes vertical, and with head well screened for some time before he made his settings, the deviations were in all cases clockwise if he lay on his right side and counter-clockwise if he lay on his left side, whether he used one eye or both. The magnitudes of the deviations, though very different with different people, were often as great as 20°.

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THE DEVONIAN SYSTEM IN CANADA.

II.

2. ONTARIO AND KEEWATIN (HUDSON BAY).

While Logan was exploring the Gaspé sandstones in 1843, Mr. A. Murray, then Assistant Geologist to the Canadian Survey, was engaged in a "geological examination of the district lying in a general line between Georgian Bay, on Lake Huron, and the lower extremity of Lake Erie." In his report on that year's operations, published in 1845, Mr. Murray correctly, and for the first time, regards the rocks at Port Colborne, Cayuga, etc., which he calls the Upper Limestones, as the equivalents of the Corniferous limestone of the State of New York. The black bituminous shales at Kettle Point, Lake Huron and on the Sydenham River, that he examined in 1848, he at first thought to be part of the Hamilton formation, but in 1855 he re-examined these shales and some of the exposures on the Sable River and in the township of Bosanquet, in company with James Hall, upon whose authority the former were decided to represent the lowest member of the Portage and Chemung group and the latter the Hamilton formation. But this statement was not published until 1857.

The discovery of the Oriskany sandstone at Cayuga would seem to have been made, or rather first recorded, by E. Billings, in May, 1860. For, in the preface to his now classical paper 'On the Devonian Fossils of Canada West,' Mr. Billings says that the "Devonian rocks of Canada West consist of portions of the Oriskany sandstone,

Schoharie grit, Onondaga limestone, Corniferous limestone, Hamilton, Portage and Chemung groups.'' This paper was originally published in four parts, and in the third and fourth parts, fourteen of the species of brachiopoda therein enumerated or described are said to occur in the Oriskany. The 'Geology of Canada,' published in 1863, contains a list of thirty species of fossils from the Ontario Oriskany, most of which, in the Museum of the Geological Survey at Ottawa, are labelled as having been collected by J. De Cew. In that publication it is stated that only the lowest of the three divisions of this formation extends into Ontario; that it occupies only a few small areas in the townships of Dunn, Oneida and Cayuga, as a 'very narrow border' to the Corniferous, and that it 'seldom exceeds about six feet in thickness.' A 'list of the fossils occurring in the Oriskany sandstone of Maryland, New York and Ontario,' by Mr. Charles Schuchert, published in 1889, in the 'Eighth Annual Report of the Geologist of the State of New York,' contains the names of seventy-six species from Cayuga. Most of the Ontario material from which this list was made was probably obtained from Mr. De Cew. But Mr. Schuchert, who made additional collections of the fossils of the Ontario Oriskany for the United States National Museum in 1895, says, in a recent letter to the writer, that he then saw how easy it is to mix Oriskany and Corniferous fossils while collecting, and believes that the collections made by Mr. De Cew are mixed. Mr. Schuchert thinks that near Cayuga there is a transition zone between the Oriskany and the true Corniferous, and that many of the fossils recorded in the 'Geology of Canada' as from the Oriskany may be from this zone. Further, he is of the opinion that it is only the uppermost portion of the Oriskany that is represented near Cayuga.

The fossils of the Corniferous formation or Upper Helderberg group of Ontario have been determined or described, either separately or together with those of the Hamilton formation, by E. Billings and Professor H. A. Nicholson, in Canadian publications ranging from 1857 to 1895. Incidentally they have been described or enumerated by James Hall in the thirty-fifth regents' report of the New York State Cabinet of Natural History, and in volumes four to eight of the Paleontology of that State, also by Dr. Carl Rominger in his 'Fossil Corals' of Michigan.

Tabulating the information obtainable from these and other sources, and omitting names that have long been known to be synonyms, the number of species of fossils that have been recorded from this formation in Ontario would seem to be 258, as follows:

Corals (inclusive of Stromatoporoids)	100
Vermes	1
Polyzoa (= Bryozoa)	40
Brachiopoda	60
Pelecypoda (=Lamellibranchiata)	10
Gasteropoda	17
Cephalopoda	8
Ostracoda	1
Trilobita	17
Fishes	4
	258

In addition to these, there are in the Museum of the Canadian Survey, a few fragmentary crinoids, several species of polyzoa, a few brachiopoda, pelecypoda and gasteropoda, and one pteropod (an undetermined species of *Tentaculites*) from the Corniferous of Ontario, that have yet to be studied.

From this list it would appear that corals form by far the most conspicuous feature in the fauna of the Ontario Corniferous. But, although in places this formation is mainly a large coral reef, it is obvious that quite a number of the species that have been proposed therefrom are based upon very insufficient characters. For some time past the writer's friend and colleague, Mr. L. M.

Lambe, has been engaged in a much-needed revision of the Canadian paleozoic corals, and when this revision is completed, as it is hoped it soon will be, it will doubtless materially reduce the number of species from the Corniferous of the province. On the other hand, the number of species of polyzoa, brachiopoda and mollusca from that formation, in collections that have yet to be studied, will be quite largely increased.

The fossils of the Hamilton formation of Ontario have been reported on by Billings, Nicholson, Hall, and more recently by the writer, who has published two small monographs upon them. In the latter of these, published in November, 1898, 219 species are recognized and recorded, as follows:

Sponges	2
Corals (inclusive of Stromatoporoids)	40
Echinodermata	16
Vermes	14
Polyzoa (= Bryozoa)	40
Brachiopoda	61
Pelecypoda (= Lamellibranchiata)	13
Gasteropoda	12
Pteropoda	3
Cephalopoda	8
Ostracoda	3
Phyllopoda	1
Trilobita	4
Fishes	2
	219

Several additional species of Fenestellidæ and Monticuliporidæ are indicated in the Canadian Survey and other collections by mere fragments that have not yet been critically examined. From a comparison between the foregoing lists it would appear that echinodermata and vermes are more numerous in genera and species in the Hamilton formation than in the Corniferous, but eight of the fourteen specimens of vermes from the Hamilton formation are jaws or teeth of conodonts that are very small and difficult to find.

The black shales at Kettle Point, which are supposed to represent the Genesee slates of the State of New York, have so far yielded only a still undetermined *Lingula*, and four species of fossil plants (*Calamites inornatus*, *Lepidodendrum primævum*, macrospores of *Protosalvinia Huronense*, and a *Spirophyton*) that have been determined or described by Sir William Dawson.

The Tully limestone, the supposed representative of the Cuboides zone of the European Devonian, and the Naples beds, or Intumescens zone, of western New York, have not yet been recognized in Ontario.

One of the results of the explorations of Dr. R. Bell in 1871, 1875, 1877 and 1886, on behalf of the Geological Survey of Canada, was the discovery of a large area of Devonian rocks to the west and southwest of James Bay. In 1871 Dr. Bell collected a few fossils on the Albany River (which is now part of the dividing line between Ontario and the District of Keewatin) between Marten's Falls and the Forks; and in 1886 a much larger number on the same river below the Forks. Some of these fossils are from a yellowish gray limestone, and those obtained from this limestone in 1886 represent seventeen species. Twelve of these appear to be identical with Corniferous species from Ontario and New York State, and the remainder are either undeterminable or undescribed. Others are from small patches of red marl, and these fossils seem to indicate the Hamilton formation, the prevalent species being perfect and well preserved specimens of *Spirifera pennata* (Atwater), formerly known as *S. mucronata*, Conrad.

Collections of fossils that are obviously of Devonian age were made by Dr. Bell in 1875 and 1877 on the Moose River and two of its larger tributaries, the Missinaibi and Mattagami. Lists of these fossils, most of which are identical with well-known Corniferous species, were published in the 'Reports of Progress of the Geological Survey of Canada' for 1875–76 and 1877–78. For many years a number of fossils from

the Devonian rocks of the Albany River at Old Fort Henley and of the Moose River, collected by the late Mr. George Barnston about 1834 or 1835, have been in the Museum of the Canadian Survey, but nothing appears to have been published about them.

In Keewatin a few fossils that are probably of Devonian age were collected in 1886 by Dr. R. Bell at two localities on the Attawapishkat River, and by Mr. Low from the Limestone Rapids on the Fawn branch of the Severn River. These fossils have not yet been critically studied, but among those from the last-mentioned locality there is a recognizable fragment of *Sphærospongia tesselata*, which is one of the most characteristic species of the Stringocephalus zone of the Manitoba Devonian. The existence of Devonian rocks on Southampton Island has been quite recently inferred from the fact that a few fossils from that island lent to Dr. Bell by a missionary in 1898 are similar to those from the Attawapishkat River. Dr. Bell had previously stated that the limestone on Southampton Island is "evidently exactly the same as that of Mansfield Island."* If this be the case the limestone of Mansfield Island may possibly be Devonian, rather than Cambro-Silurian as previously supposed.

3. MANITOBA AND THE NORTH-WEST TERRITORIES.

The Devonian age of the limestones on Snake Island, Lake Winnipegosis, and Manitoba Island, in the lake of that name, was asserted by E. Billings in 1859, on the evidence of a few fossils collected therefrom in 1858. At that time Mr. Billings was under the impression that these limestones are, as he says, 'most probably about the age of the Hamilton group.'† In 1874 Dr. J. W. Spencer collected some fossils, which Mr. Billings pronounced to be also of Devonian age, from rocks on the islands and shore of Swan Lake and on the western shore of Dawson Bay, Lake Winnipegosis. Still more recently an almost exhaustive geological examination of the islands, shores and immediate vicinity of lakes Manitoba and Winnipegosis was made by Mr. J. B. Tyrrell in 1888 and 1889. Assisted by Mr. D. B. Dowling, Mr. Tyrrell also made an exceptionally large collection of the fossils of the Devonian rocks of this region. This collection, which has been reported on somewhat fully by the writer in two illustrated papers published in 1891,* and 1892,† was found to consist of 133 species, but about nineteen of these could not then be determined specifically. Two additional species of corals in this collection have since been determined, and an additional species of pteropoda from a collection made later has been described, making the total of identified or described species now known from these rocks to be 117, as follows:

Sponges (inclusive of Receptaculitidæ)	2
Corals (inclusive of Stromatoporoids)	17
Vermes	1
Polyzoa (= Bryozoa)	5
Brachiopoda	18
Pelecypoda	25
Gasteropoda	29
Pteropoda	2
Cephalopoda	9
Ostracoda	3
Trilobita	3
Fishes	3
	117

According to Mr. Tyrrell these fossils are exclusively from the Middle and Upper Devonian of the province, for the Lower Devonian has not yet been satisfactorily recognized in Manitoba, though it may be

* Geological and Natural History Survey of Canada, Report of Progress for 1882–83–84, p. 34 D.D.

† Hind's report on the Assiniboine and Saskatchewan Exploring Expedition, Toronto, p. 187.

* Transactions of the Royal Society of Canada, Vol. VIII., Sec. 4, p. 93.

† Geological Survey of Canada, Contributions to Canadian Paleontology, Vol. I., pt. 4.

represented by about 100 feet of red and other shales, from which no fossils have yet been collected. In any case they are of special interest as showing certain well marked and not altogether unexpected points of resemblance to those of the English and European Devonian. For, the upper half of the Manitoba Middle Devonian, or Winnipegosan formation of Mr. Tyrrell, consists of a tough white dolomitic limestone holding numerous examples of a large *Stringocephalus* which is apparently identica with the *S. Burtini* of Defrance and other European authors. Moreover, it is here associated with many fine specimens of *Sphærospongia tesselata*, Phillips, and with fossils that cannot at present be distinguished from the following well-known European species:

Cladopora cervicornis (De Blainville).
Spirorbis omphalodes, Goldfuss.
Productella productoides (Murchison).
Stropheodonta interstrialis (Phillips).
Atrypa reticularis, L.
Atrypa aspera, Schlotheim.
Pugnax pugnus (Martin).
Paracyclas antiqua (Goldfuss).
Murchisonia turbinata, Schlotheim.
Euomphalus annulatus, Phillips.
Loxonema priscum, Munster.
Macrochilina subcostata (Schlotheim).

The Stringocephalus limestone of Manitoba would seem to occupy much the same stratigraphical position as that of Devonshire, Rhenish Prussia and Belgium, and its fossils show that it is probably their homotaxial equivalent.

Immediately above the Stringocephalus zone in Manitoba there are beds which may possibly represent the Cuboides zone, although *Rhynchonella*, or, as it is now called, *Hypothyris cuboides*, has not yet been found in them. The prevalent fossils in these beds are *Cyathophyllum dianthus* and *C. vermiculare*, var. *præcursor* (teste Frech); *Chonetes Logani* var. *Aurora*, *Productella subaculeata*, *Orthis striatula*, *Stropheodonta arcuata*, and *Cyrtina Hamiltonensis*, which the Rev. G. F. Whidborne has recently asserted is the same as the European *C. heteroclita.*

Regarding the fossils of the Manitoba Devonian as a whole, it is to be noted that it is not the corals, nor the polyzoa (or bryozoa), nor the brachiopoda that have as yet yielded the largest number of species (as they have in Ontario), but the gasteropoda and pelecypoda.

From the northern end of Lake Winnipegosis the Devonian rocks extend into the immediately adjacent district of Saskatchewan.

It has long been known that the eastern ranges of the Rocky Mountains in Alberta are mainly composed of Carboniferous or Devonian, or perhaps of Carboniferous *and* Devonian, limestones and shales. These rocks were examined in 1858 and 1859 by Sir James Hector, who writes as follows in regard to them:

"These limestones are of dark and light blue colour, crystalline, compact or cherty, with fossils that are either of Carboniferous or Devonian age, the principal of which are *Spirifer*, *Orthis*, *Chonetes*, *Conularia*, *Lonsdalia*, *Cyathophyllum*, *Lithostrotion*, etc." * * * "Along with them are softer beds of gritty, sandy shale, generally of a dull red or purple colour." * * * "In the second range we have the same limestones and shales repeated as in the first, but at the base I observed traces of a magnesian limestone of a buff colour, containing *Atrypa reticularis*, a true Devonian fossil."† * * * "On the Kicking Horse River, in the third range, we have the mountains again formed of blue limestone, along with a compact blue schist with red bands, giving a curious striped aspect to the rocks." ‡

In reference to these remarks, Dr. G. M. Dawson, who made a geological examination of the South Kootanie Pass and its vicinity, in 1874, adds the following comments:

"Dr. Hector is not very clear as to the separation of the supposed Devonian and Carboniferous limestones, and they may indeed very probably belong to

* Palliser's Explorations in British North America, 1863, p. 239.

† Quarterly Journal of the Geological Society of London, Vol. XVII., 1861, p. 443.

‡ Palliser's Explorations in British North America, p. 239.

a single series. Professor Meek, in describing fossils from limestones occurring in the mountains south of the boundary line, which, from the general facies, he believed to be Carboniferous, mentions the fact that the forms, without exception, belong to genera which are common both to that formation and the Devonian, and of which a small number are represented in the Silurian." *

In 1881, 1883 and 1884 Dr. Dawson was engaged in an examination of the geological structure of parts of the Rocky Mountains in Alberta between Lat. 49° and Lat. 51° 30′, the results of which were published in the 'Annual Report of the Geological Survey of Canada' for 1885 (Vol. I., New Series). This report contains preliminary lists of a few supposed Devonian fossils, from the limestones on the summit of the North Kootanie Pass, on Crow Nest Lake, and from the lowest beds exposed at the west end of the cañon on the Cañon branch of the Elbow River.

Subsequently Mr. R. G. McConnell made a geological survey of the Rocky Mountains between the Canadian Pacific Railway and the North Saskatchewan in 1885, and a more detailed exploration than had yet been made, of the geology of those in the more immediate neighborhood of that railway, in 1886. He published in the 'Annual Report of the Geological Survey of Canada' for 1886 a geological section across the Rocky Mountains in the vicinity of the Canadian Pacific Railway, with a diagram showing the formations represented in the sections to the west of the Castle Mountain Range, and another of those represented in sections to the east of that range. In the latter only four geological systems or formations are recognized, namely, the Cambrian, which Mr. McConnell calls also the 'Castle Mountain Group'; the Devonian, which he designates also as the 'Intermediate Limestone'; the Devono-Carboniferous, which he calls the 'Banff Limestone'; and the Cretaceous. In the text it is stated that the Intermediate Limestone is "mainly composed of a great series of brownish dolomitic limestones and has a thickness of about 1500 feet." Its fossils are "usually badly preserved and consist mainly of almost structureless corals." The few that were collected, it may be added, have not yet been determined and indeed are scarcely determinable. According to Mr. McConnell, the Banff Limestone is the "principal constituent of all the longitudinal ranges east of Castle Mountain." It "has a total thickness of about 5,100 feet and is divisible into a lower and upper limestone and into lower and upper shales." Its fossils are better preserved than those of the Intermediate Limestone, and fairly large and representative collections of the former were made.

These collections have not yet been at all exhaustively studied, but most of the species represented in them are apparently of Carboniferous age. Among those collected in 1886 are two or three small species of *Productus*; a large *Syringothyris*; a *Pugnax* closely allied to if not identical with *P. Rockymontana*, Marcou; a *Hustedia* like *H. Mormoni* (Marcou); and two well-marked pygidia of *Prœtus peroccidens*, Hall and Whitfield. The specimens from the black fissile shales of the Bow River, collected by Mr. McConnell in 1885, that were provisionally referred to the Devonian genus *Clymenia* on page 18 D of his report, do not show clear indications of either septa or siphuncle, and may, therefore, be casts of a discoidal gasteropod. On the other hand, in 1885 Mr. McConnell obtained a few specimens, that are unquestionably referable to *Atrypa reticularis*, from the Rocky Mountains at the Pipestone Pass Falls, and from the first range on the North Saskatchewan. It was from the mountains at the source of the North Saskatchewan that

* 'Report on the Geology and Resources of the Region in the Vicinity of the Forty-ninth Parallel,' etc., 1875, p. 71.

the specimens were collected by Sir James Hector which Salter referred to *A. reticularis.*

In 1898 Mr. J. McEvoy collected a few fossils at several localities in the first foothill of the Rocky Mountains, in Alberta, where it intersects the valley of the Athabasca. These fossils have not yet been very critically examined, but those from two of these localities are probably Carboniferous, and the remainder either Carboniferous or Devonian.

In 1868 Mr. F. B. Meek published a paper entitled 'Remarks on the Geology of the Valley of the Mackenzie River, with figures and descriptions of Fossils from that region, in the Museum of the Smithsonian Institution, chiefly collected by the late Robert Kennicott, Esq.,' in the first volume of the Transactions of the Chicago Academy of Sciences. The paper consists of a concise history of the discovery of Devonian rocks at various localities in the Athabasca, Mackenzie River and Yukon districts by Sir John Franklin, Sir John Richardson, Mr. A. K. Isbister, Major R. Kennicott, Mr. R. W. McFarlane, Mr. B. R. Ross and the Rev. W. W. Kirby, followed by descriptions or identifications of thirty-two species of Devonian fossils. Of these species ten are corals, twenty-one are brachiopoda and the remaining one is a cephalopod. Mr. Meek expresses the opinion that the Devonian rocks exposed on the Clearwater, Athabasca, Slave, and Mackenzie Rivers, and on Great Slave Lake, are probably referable to the Hamilton formation.

Since 1868 Devonian rocks have been discovered or examined by officers of the Geological Survey of Canada, and their fossils collected at the following localities in this region. In the Athabasca district, at four different exposures on the Athabasca River and at one each of its tributaries, the Clearwater, Red and Pembina Rivers, by Professor Macoun in 1875, by A. S. Cochrane in 1881, by Dr. R. Bell in 1882 and by R. G. McConnell in 1890; also at three different exposures on the Peace River by Professor Macoun in 1875 and by Mr. McConnell in 1879. In the Mackenzie District, on the banks of the Long Reach of the Lower Liard River and on the Hay River forty miles above its mouth by Mr. McConnell in 1887, and at four different and rather widely distant exposures on the Mackenzie River by Mr. McConnell in 1888.

Most of the fossils from these localities that were collected before 1875 have been provisionally reported on in the Reports of Progress of the Canadian Survey for the years in which they were made. Those, however, that were collected between the years 1875 and 1890, both inclusive, form the subject of an illustrated paper, by the writer, on 'The Fossils of the Devonian Rocks of the Mackenzie River Basin,' published in 1891.* This publication, which is practically a continuation of Mr. Meek's paper on the same subject, already referred to, adds fifty-seven additional species of purely marine invertebrata to the previously known fauna of these rocks, as under:

Sponges	1
Corals (inclusive of Stromatoporoids)	10
Crinoidea	1
Vermes	3
Polyzoa (= Bryozoa)	7
Brachiopoda	20
Pelecypoda	7
Gasteropoda	3
Pteropoda	1
Ostracoda	3
Trilobita	1
Total	57

According to Mr. McConnell, a section of the Devonian rocks in the Mackenzie district, in descending order, would be somewhat as follows:

1. Upper limestone ....(about) 300 feet
2. Greenish and bluish shales alternating with limestone (about) 500 feet

* Geological Survey of Canada, Contributions to Canadian Paleontology, Vol. I., part 3.

3. Grayish limestone, interstratified with dolomites, the lower part of which may be older than the Devonian..................	2,000 feet (or more)

The whole of the fossils collected by Mr. McConnell, Professor Macoun and Dr. Bell are from the upper part of the middle division of this section. Of the fifty-seven species of fossils in the foregoing list, twenty-two are apparently found also in the Hamilton formation of Ontario and the State of New York; ten (but only six additional ones) in the Devonian rocks of Iowa now referred to the Chemung; and seven in the Chemung of the States of New York and Pennsylvania. On the other hand, there are strong reasons for supposing that the whole of these fossils are from a horizon nearly corresponding to that of the 'Cuboides zone' of Europe. In the first place, three specimens of a brachiopod which the writer has identified with the *Rhynchonella* (now called *Hypothyris*), *cuboides* of Sowerby, were collected by Mr. McConnell, one at the Hay River in 1887, and two on the Peace River at Vermilion Falls in 1889. It is true that Mr. Schuchert thinks that these three specimens should be called *Hypothyris Emmonsi*, but Mr. Walcott had previously expressed the opinion (in 1884) that "there is little doubt but that *Rhynchonella intermedia*, *R. Emmonsi* and *R. venustula*, Hall, are varieties of *R. cuboides*,* of the Devonian of Europe." On the Hay and Peace Rivers the supposed *Hypothyris cuboides* is associated with *Spirifera disjuncta* (or *Verneuili*), and other fossils that are elsewhere supposed to be characteristic of the Cuboides zone are to be met with in the published lists of species from the Athabasca and its tributaries, or the Mackenzie. The discovery by Mr. McConnell, at the Ramparts on the Mackenzie River, of two large specimens of a *Stringocephalus* which cannot at present be distinguished from *S. Burtini* may indicate a northwestward extension of the Stringocephalus limestone of Manitoba. The still later recognition by Dr. John M. Clarke, in 1898, of *Manticoceras intumescens* in the cast of the interior of three chambers of the septate portion of a species of Goniatite from the Hay River, collected by Mr. McConnell and figured by the writer, would seem to indicate the existence of the equivalent of the 'Intumescens zone,' or Naples fauna at that locality.

* Monographs of the United States Geological Survey, Vol. VIII. (Paleontology of the Eureka District), page 157.

The present state of our knowledge of the Devonian rocks of the whole Dominion, from a purely paleontological standpoint, may be thus briefly summarized. We now possess a fairly satisfactory knowledge of the fossils of the Devonian rocks of Ontario, and of the relations which these rocks bear to the typical section in the State of New York. The fossil plants of the Gaspé sandstones have been described and figured by Sir William Dawson, and the remarkable assemblages of fossil fishes from the Upper Devonian of Scaumenac Bay and Lower Devonian near Campbellton have been worked out somewhat exhaustively, the earlier collections in Canada, and the later ones by the best ichthyological authorities in London and Edinburgh. We have now some idea of the fossil fauna of the Manitoba Devonian, and have added materially to our knowledge of the fossils of the Devonian rocks of the Athabasca and Mackenzie River districts. But, on the other hand, our knowledge of the organic remains of the Devonian of Nova Scotia is still in its infancy, and it would seem that the plant-bearing beds near St. John's, N. B., which have so long been regarded as Devonian, may possibly be Carboniferous. In the Rocky Mountain region of Alberta we have not always succeeded in distinguishing Devonian rocks

from Carboniferous, and we have yet to obtain a much fuller knowledge than we now possess of the Devonian fossils of Keewatin and the area to the southwest of James Bay.

J. F. Whiteaves.

Ottawa, June 28, 1899.

SECTION B—PHYSICS.

The work of this section at the Columbus meeting was extremely gratifying to those who were fortunate enough to attend; although no papers of an epoch making nature were presented, still all those which were read were of a good character, and seemed to represent a large part of the work in physics in this country, for the past year or more. Several of the papers were of considerable importance, and it is hoped that they will find their way into the columns of this Journal before long.

The meetings of the section were well attended and the discussions were intelligent, interesting and to the point. It should be a matter of congratulation that the Association succeeded in collecting at Columbus so large a number of working physicists and presented such a good series of papers. It seems that more and more such scientists and such papers as are found at the meetings of the British Association are coming to these meetings.

The address of the Vice-President, Dr. Elihu Thomson, 'On the Field of Experimental Research,' was published in Science for August 25th.

Professor Caldwell presented a number of interesting diagrams, which by appropriate super-position enable one to point out the constants of current and electromotive force in the rotary converter. These diagrams must be extremely useful in presenting the complex question of the operation of these machines.

Professor Eddy showed a simple and convenient method for constructing the entropy-temperature diagrams of a gas or oil engine from the indicator card; and showed how these diagrams enable one to readily detect the advantages or defects in the running of such engines.

Mr. Briggs' new variable condenser consists of a series of alternating plates of mica and spring brass. The capacity is increased by compressing the plates together by means of a thumb-screw.

In photometric operations we are accustomed to compare the relative illumination of two surfaces by looking at them, and guessing at their relative intensity, or by endeavoring to make the illumination of the two surfaces equal. In Professor Cattell's method, however, the difference between the two surfaces is measured by the time it requires for the observer to decide which of the two surfaces is the brighter; it being a fair assumption that the difference in the impressions is a function of the time required to distinguish between them. A considerable series of observations have confirmed the belief that this method is not only applicable but highly advantageous.

In Professor Cattell's other paper, he brought before the section an extremely interesting and novel observation, which must throw considerable light upon the relative importance of the retina and the brain in the operation of vision. He finds that if, by a motion of the eye, the images of black and white bars are made to pass over the retina at the rate of even a hundred or a thousand per second, still the eye or the brain perceives them as individual bars, and not as a fused gray surface; of course, when the eye is stationary, if light and dark images are caused to pass over the retina at a much less rate, we have perfect fusion. Thus it seems a matter of vital importance in distinct vision, when the image moves on the retina, whether the eye is moving and the object stationary, or the reverse. These experiments indicate that the phenomena of vision are chiefly cerebral

and not chiefly retinal, and that our operation of vision has been developed by evolution to that which is necessary for convenience and self-preservation.

The two papers by Mr. Wead were of special interest from the historical point of view, presenting on the one hand, with considerable elaboration, the development of the organ pipe as seen in the various instructions as to their manufacture, length and other dimensions ; incidentally the perfection of the organ pipe at any particular era, of course, enables us to judge to some extent as to the musical conditions existing at that time. In the study of the literature of the musical scale, much interesting information has been obtained with reference to the so-called Arab scale, extant descriptions of certain Arab musical instruments, such as the lute, the tambour of Bagdad and others, enable us to see the way in which the musical scale was built up, and how, in many cases, the interpolation of a note in the scale was determined, not by conditions of harmony, but by the dimensions of the neck and the location of frets upon the instrument in use.

A thoroughly new phenomenon in connection with the effect of an alternating current of electricity upon the human system was presented by Dr. Scripture. He has found that when the alternations in a current of electricity become as frequent as 5,000 per second, the nerves of the part affected cease to react to pain, that is, a high frequency alternating current, instead of producing the muscular contraction brought about by lower frequency, produces a local anesthesia or rather analgesia ; the current should be sinusoidal with equal positive and negative phases. Experiments have been tried in sending the current along the superior maxillary nerve with a view of cutting off the teeth from connection with the brain ; as yet, however, the frequency has not been high enough to obviate contraction of the facial muscles. It would appear that in this phenomenon we have a very valuable contribution to the methods of surgery.

Messrs. Carhart and Guthe have continued their absolute determination of electrical units, and now offer the valve 1.4333 volts at 15° C. as the electromotive force of the standard Clark Cell.

In Mr. Trowbridge's paper on the coherer, we have a praiseworthy endeavor to present quantitative results, instead of haphazard observations upon this instrument which has recently become so important. Using a coherer consisting of 22 hard steel balls in a glass tube, he was able to discover the conditions of current and pressure necessary for the operation of a coherer ; he found, for example, that a minimum electromotor force of from 8 to 10 volts is necessary to break down the resistance of the coherer, but that after the resistance had been broken, subsequent discharges do not reduce the resistance much further ; it thus would appear that it is the first rush of the electricity through the coherer which produces the result, and that subsequent discharges are without useful effect ; that is, an oscillatory discharge is not necessary, a single impulse is sufficient. This observation explains much of the confusion that has puzzled workers in wireless telegraphy.

In No. 12 and No. 16 were presented observations and conclusions with reference to the complex operations that take place in an electrolytic cell. The relations between polarization, capacity and resistance being an extremely puzzling question.

In No. 13 was presented the fact that a magnetic field surrounding an alternating current arc tends to flatten the top of the electric wave and to increase the efficiency. A similar effect is produced by an aluminum electrolytic cell where the formation of a film of oxide acts like the dielectric of a condenser, and reverses the phrase.

In No. 15 the difficulty of determining permeability and hysteresis is pointed out, and it is shown that the pull in the permeater should be represented by

$S(B^2 - B{\cdot}\mathrm{H})/8\pi$ instead of $S(B^2 - H^2)/8\pi$.

Mr. Wolff told the section of the present condition of the office of standard weights and measures at Washington, and the progress that has been made toward the equipment of the laboratory for the verification of electrical apparatus. It is gratifying to know that even now we have a trustworthy bureau to which electrical standards may be sent for testing.

He also presented some experiments as to whether current density affects resistance, that is as to the universal truth of Ohm's law. If the resistance is expressed as a function of current density in the following form:

$R_c = R_o\left\{1 + h\left(\frac{c}{s}\right)^2\right\}$, $\frac{c}{s}$ is current density, then h cannot be greater than 1/600,000,000.

In No. 20 were presented some extremely interesting and important generalizations with reference to the effect of broad areas of atmospheric pressure upon the weather. This paper will appear in *The American Journal of Science.*

Mr. Brace in No. 21 and No. 22 presented some interesting optical matter whose appearance in detail in the journals will be awaited with interest.

Certainly one of the most important papers presented was No. 23, in which Mr. Fessenden presented a large mass of theoretical and experimental material tending to give a clue as to the nature of electricity and magnetism, and also to give a value for the elasticity and density of the ether. He pointed out the great advantage of discussing physical problems by means of dimensional formulæ, showing that these were particularly valuable in pointing out the direction in which the investigation should tend, and in checking the results of more elaborate mathematical analysis. A detailed abstract of this paper is not embodied here, because it is believed that it will appear in SCIENCE before long.

Everyone is now interested in the question of smokeless powder, and the freedom from observation which it gives to the soldier. It is interesting to see in this connection from No. 25, that Mr. Fessenden has discovered a very simple and apparently effective means of locating the flash from smokeless powder, by simply providing the observer with a piece of pale red glass, it having been found that these flashes are strong in red light, whereas the general landscape is very weak in red.

In No. 28 Mr. Fessenden raised the question as to whether it is necessary to suppose that the conditions of terrestrial radiation have always been similar to those which exist at present; in other words, as to whether Lord Kelvin's estimate for the age of the earth which has been declared entirely inadequate by biologists, may not have to be extended, owing to an earlier excessive rate of radiation, due to the absence of a blanketing atmosphere.

No. 29 and No. 30 are valuable contributions to the subject of the wave-length of energy radiated from 'black' bodies at various temperatures.

In No. 32 Mr. Cook has made some interesting computations as to the conditions of time and temperature necessary for a planet to lose an atmosphere consisting of gases, ranging in density from carbonic acid gas to hydrogen.

No. 36 gives a continuation of Mr. Gray's interesting investigation upon the dielectric strength of oils. He finds, for example, that the strength per cm. decreases as the layer increases in thickness.

In No. 37 he has called attention to an error in a new Watt-meter, caused by the

resistance coils absorbing moisture from the atmosphere, and also to the effects of capacity around the fine wire coil of a Wattmeter.

The full program was as follows:

1. Apparatus for the demonstration of the varying currents in the different conductors of a rotary converter. F. C. Caldwell, Columbus, O.

2. A new graphical method of constructing the entropy-temperature diagram from the indicator card of a gas or oil engine. H. T. Eddy, Minneapolis, Minn. Trans. Am. Soc. Mech. Eng.

3. Compound harmonic vibration of a string. W. Hallock, New York, N. Y. SCIENCE.

4. A new form of electrical condenser, having a capacity capable of continuous adjustment. Lyman J. Briggs, Washington, D. C.

5. Relations of time and space in vision. J. McK. Cattell, New York, N. Y. *Psychological Review.*

6. Time of perception as a measure of the intensity of light. J. McK. Cattell, New York, N. Y. *Psychological Review.*

7. The musical scales of the Arabs. Charles K. Wead, Washington, D. C.

8. Medieval organ pipes and their bearing on the history of the scale. Charles K. Wead, Washington, D. C. '*Music,*' Chicago.

9. Electrical anesthesia. E. W. Scripture, New Haven, Conn.

10. An absolute determination of the E.M.F. of a Clark cell. H. S. Carhart and K. E. Guthe, Ann Arbor, Mich. *Physical Review.*

11. Quantitative investigation of the coherer. Augustus Trowbridge, New Haven, Conn. *Am. Jour. Sci.*, Sept., 1899.

12. Polarization and polarization capacity of an electrolytic cell. K. E. Guthe and M. D. Atkins, Ann Arbor, Mich. *Physical Review.*

13. Current and voltage curves in the magnetically blown arc and in the aluminum electrolytic cell. Reginald A. Fessenden, Allegheny, Pa.

14. Some new apparatus — tachometer, chronograph, data collector, induction coil, balance for standardizing amperemeters, standard of induction. Reginald A. Fessenden, Allegheny, Pa.

15. Measurement of magnetism in iron and the relation between permeability and hysteresis. Reginald A. Fessenden, Allegheny, Pa.

16. Polarization and internal resistance of the copper voltameter. B. E. Moore, Lincoln, Nebr. *Physical Review.*

17. Concerning the fall of potential at the anode in a Geissler tube. C. A. Skinner, Lincoln, Nebr. *Wiedemann Annalen.*

18. The equipment and facilities of the Office of U. S. Standard Weights and Measures for the verification of electrical standard and measuring apparatus. F. A. Wolff, Jr., Washington, D. C.

19. An experimental test of the accuracy of Ohm's law. F. A. Wolff, Jr., Washington, D. C.

20. March weather in the United States. O. L. Fassig, Baltimore, Md. *Am. Jour. Sci.*

21. A new spectrophotometer and a method of optically calibrating the slit. D. B. Brace, Lincoln, Nebr.

22. On achromatic polarization in crystalline combinations. D. B. Brace, Lincoln, Nebr.

23. On the nature of electricity and magnetism and a determination of the density and elasticity of the ether. Reginald A. Fessenden, Allegheny, Pa. SCIENCE. Read in joint session with Section A.

24. Advances in theoretical meteorology. Cleveland Abbe, Washington D. C. Read by title.

25. Location of smokeless powder discharge by means of colored screens. Reginald A. Fessenden, Allegheny, Pa.

26. A method for the study of phosphorescent sulphides. Fred E. Kester, Columbus, O. *Physical Review.*

27. Accidental double refraction in colloids and crystalloids, B. V. Hill, Lincoln, Nebr. *Philosophical Magazine.*

28. Note on the age of the earth. Reginald A. Fessenden, Allegheny, Pa.

29. A bolometric study of the radiations of a black body between 600° C. and 1100° C. C. E. Mendenhall, Williamstown, Mass. *Astrophysical Journal.*

30. A bolometric study of the radiations of an absolute black body. F. A. Saunders, Haverford, Pa. *Astrophysical Journal.*

31. On thermodynamic surfaces of pressure-volume-temperature for solid, liquid and gaseous state. F. E. Nipher, St. Louis, Mo. Trans. St. Louis Acad. Sci. Read by title.

32. On the escape of gases from the planets according to the kinetic theory. S. R. Cook, Lincoln, Nebr. *Astrophysical Journal.*

33. On differential dispersion in double refracting media. E. J. Rendtorff, Lincoln, Nebr.

34. Relation of magnetization to the modulus of elasticity. J. S. Stevens, Orono, Me. *Physical Review.*

35. On flutings in the Kundt sound tube. S. R. Cook, Lincoln, Nebr. *Philosophical Magazine.*

36. Dielectric strength of oils. Thomas Gray, Terre Haute, Ind.

37. Some unexpected errors in watt-meter measurements. Terre Haute, Ind.

38. Note on the preparation of reticles. David P. Todd, Amherst, Mass Read by title.

39. The nature of spoken vowels, with reference to the theories of Helmholtz and Hermann. E. W. Scripture, New Haven, Conn. Read by title.

40. Pressure and wave-length. J. F. Mohler, Carlisle, Pa. Read by title. *Astrophysical Journal.*

41. The attenuation of sound and the constant of radiation of air. A. Wilmer Duff, Ithaca, N. Y. Read by title. *Physical Review.*

42. Optical calibration of the slit of a spectrometer. E. V. Capps, Lincoln, Nebr.

William Hallock,
Secretary.

Columbia University.

SECTION I.—SOCIAL AND ECONOMIC SCIENCE.

Seventeen papers were announced, fourteen of which were given in full and three were read by title. The address of the Vice-President, Dr. Marcus Benjamin, will be published in a subsequent number of Science.

There were four morning sessions and two afternoon sessions, and the interest was sustained till 3:30 on the last day.

The first paper was by Mr. John Hyde, of the U. S. Department of Agriculture, on 'The Relation of Indian Corn to the Wheat Problem.' Mr. Hyde traced the development of corn raising and wheat raising from their beginnings, showing that wheat had passed a maximum while corn was apparently approaching one. Though quite independent in production, the sympathetic agreement in price is remarkable. Mr. Hyde predicted a permanent foothold and an increasing demand for American corn. While the United States is admirably fitted for corn the same is true of relatively few other lands. Wheat may be sown either in the spring or fall, and in many lands. We cannot expect to control the wheat market, but we can the corn.

Miss Cora A. Benneson, a lawyer of high standing on Federal matters, gave a paper on 'Federal Guarantees for Maintaining Republican Government in the States,' in which she pointed out that the constitution guaranteed to every State in the Union a republican government without defining what this is. This power has been used in regard to disputed possession of territory, to suppress riots, etc., and the reconstruction following the Civil War, federal intervention was constantly needed, even beyond those warranted by the constitution. It is a question how far the provision of the constitution guarantees a republican form of government to territories, it depending on what is included under 'United States.'

Mr. Henry Farquhar, of the U. S. Department of Agriculture, gave a short paper on 'Calculations of population in June, 1900.' The formula employed by Mr. Farquhar was

$$\triangle p = \frac{p}{e + fp + gp^2}$$

in which p is the population shown by a United States Census. $\triangle p$ is the 'natural increase' in a decade, excluding immigration; e, f, g are constants determined from former United States Censuses, after deducting immigration figures. In all his calculations Mr. Farquhar rejected the Census of 1870 as defective. The immigration for the decade ending next June he put at 3,750,000. Expressing p in millions, and calculating the constants from different sets of data, the writer produced four separate calculations of the population, as thus shown:

	e	f	g	p in 1900
A	2.862	0.035	0.00091	73,648,000
B	2.279	0.086	0.	74,693,000
C	2.570	0.073	0.	75,679,000
D	3.350	0.000	0.0012	74,466,000

The writer preferred C over the others, and concluded that the next Census would show more than 75,000,000 and less than 76,000,000.

Mrs. Florence Kelley, the Corresponding Secretary of the National Consumers' League, read a thirty minute paper on

'The Power of the Consumer, Economically Considered.' The paper was well written and admirably presented. Its general conclusions were:—The consumer, at present, has the power to decide that a given article shall not be produced, by refraining unanimously from buying it; to promote the production of a given article by demanding it; to decide within certain limits the conditions under which the production of desired articles shall be carried on. The consumer has, however, hitherto done none of these things in an orderly way, except so far as coöperative buying has been practiced, and the intervention of adulteration laws and factory laws has been invoked by consumers. The power of the consumer, while potentially very great, is really slight at the present time, and increases only in proportion as consumers organize, get into direct communication with manufacturers, and inform themselves minutely with regard to the conditions of production.

Professor Mansfield Merriman presented a study of the 'Median Age of the Population of the U. S.,' showing a marked and steady increase. His results were derived from curves obtained from the Census reports. The *abscissas* of the platted points were the ages from 0 to 100 or above. The ordinates represented the summation of all the population below the ages represented by the corresponding abscissas. For example: on the curve representing the census of 1890, the ordinate at the abscissa 20, represented the number of persons enumerated in the census of 1890 whose age was *20 or less.* The curves become tangent to the lines of total population at about 104 years.

The abscissa of the point where the curve crosses the line of *half the population* marks the 'median age' since one-half of the whole people are less than that age and one-half are more than that age. In addition to the median age of all classes, the median ages of particular classes were given, as shown in the following table:

Census year.	Whites.	Native Whites.	Colored.	All Classes.
1850	18.6	——	16.5	18.3
1860	19.3	——	16.5	18.9
1870	19.9	16.2	17.7	19.6
1880	20.9	17.8	17.5	20.4
1890	21.9	18.9	17.6	21.4
1900	(22.9)	(20.0)	(17.6)	(22.4)

This indicates a steady increase in the length of life, though it does not tell what that length is.

Mr. H. T. Newcomb's paper on 'Trusts, a Study in Industrial Evolution,' was exceptionally fine in both form and substance. No brief abstract can do it justice. There was no sentiment in it, no partisan bias, but a careful and impartial statement of the growth of the various forms of combination and coöperation by both employer and employed, from partnerships through trusts to corporations; from trades unions, to the American Federation of Labor. Mr. Newcomb's paper will undoubtedly be published in some form at an early date.

Dr. Washington Gladden's paper on the 'Moral Tendencies of Existing Social Conditions' was an able discussion of the moral effects of the prevailing industrial and commercial system. Dr. Gladden is a close student of men and affairs, and his observations should have great weight. The competitive system is responsible for the tendencies whether good or ill. He enumerated the *gains* we seem to be making: 1. In common honesty. There is less of cheating and fraud in ordinary business than there were fifty years ago, though buyers are more reckless in running into debt. 2. In the development of the fiduciary virtues. Men learn to trust each other more and to deserve more confidence, notwithstanding an occasional embezzler. 3. The system enforces a valuable lesson in coöperation. Dr. Gladden believed that the big corporations

which almost control the markets, furnish better goods, edible compounds with less adulteration than formerly; and that retail buyers are less honest than retail sellers. On the other hand there were *losses* incident to the growth of the present system. 1. Men lack self-reliance and initiative. There are lessening opportunities for independent enterprise. While we learn to coöperate we lose the power to set ourselves to work. 2. The lowering of moral standards through an exaggerated popular estimate of the importance of material wealth. Against these evil tendencies there is strong resistance. The moral ideals were never more clearly held or more bravely maintained than now by teachers, preachers, writers, artists.

Probably changes in the industrial and social organization will be found needful. Doubtless the world will never be reformed by changes in the machinery of society; but doubtless the world will never be reformed without such changes. It is needful that the spirit of fellowship and coöperation be cultivated and the spirit of strife and competition be repressed.

Before Sections D and I, Mr. G. B. Morrison gave the results of experiments in heating and ventilating a model house. The paper was full of technical matters, but the grand conclusions appeared to be two in number:

1. Air, warmed to a proper temperature, should be introduced to a school room through numerous small openings in the floor throughout the room, so that the great mass of air may rise slowly and uniformly to the ceiling, and there be allowed to pass out, growing cooler as it rises.

2. Given the proper amount of air to be furnished to a crowded room, it is far cheaper to move it by fans than by an aspirating flue which requires heating for the purpose.

Mr. John S. Clark, of Boston, well known for his labors in the dissemination of works on drawing and art, read a very interesting paper on: 'Science and Art in their Relation to Social Development.' He said that scientific research to-day aims through knowledge at the solution of practical problems. Art is the product of creative activity. It is impossible to draw a sharp dividing line between industrial and fine art. Attention was then called to the relation between art on the one hand, and civilization on the other hand. He pointed out that the last century of scientific research also witnessed the development of landscape painting and of the poetry of nature. Fine art is the ultimate result of any given race or period. In art, man finds the fullest room for the exercise of his broadest powers.

A paper, by Dr. Thomas L. Balliet, 'On Some New Aspects of Educational Thought,' was one of the best of the meeting, and it commanded the closest attention and aroused the greatest enthusiasm. The discussion which followed lasted for over an hour and was participated in by Dr. Gladden, ex-President Scott, Professor C. M. Woodward and many others. It is expected that a detailed abstract of the paper will be published in SCIENCE.

In his discussion of 'The Manual Element in Education,' Professor C. M. Woodward, of the St. Louis Manual Training School, sketched the growth of the manual element from its introduction in the kindergarten, the chemical laboratory and the engineering and trade shops forty years ago, to the modern manual training school and the light tool work now introduced into the higher grades of the grammar schools. Kindergarten teachers had thus far shown their inability to extend their work into the primary school. A great wall of prejudice prevents any proper union of the first reader with the 'gifts.' But from the upper side all the grades are coming into a participation in the benefits of educational tool work and exact drawing. Every child

is entitled to a modicum of systematic manual training as a part of a rounded education.

Mr. Newcomb's paper on 'The Spoils System in Theory and Practice' was a surprisingly frank and straightforward exposition of the manner and extent to which members of Congress plunder the national treasury by creating unnecessary offices and filling them with friends who make themselves agreeable, but perform no needful public service. The paper will soon appear in print.

C. M. WOODWARD,
Secretary.

WASHINGTON UNIVERSITY.

THE AMERICAN MATHEMATICAL SOCIETY.

THE sixth summer meeting of the American Mathematical Society was held at the Ohio State University, Columbus, Ohio, on Friday and Saturday, August 25th and 26th, simultaneously with the meeting of the American Association for the Advancement of Science at that place. In attendance and range of subjects covered in the papers presented, the meeting was thoroughly representative of mathematical activity throughout the country. The President, Professor R. S. Woodward occupied the chair, and in opening the first session contrasted the present lively interest in mathematical investigation as indicated by the list of papers to be read, each of which was in some way a contribution to the sum of mathematical knowledge, with the conditions of thirty or forty years ago when the workers in mathematical science were very few and were confined within narrow limits.

The American Mathematical Society which represents the organized forces for research and the diffusion of mathematical knowledge in the United States has had a remarkable growth. It was organized upon its present basis in 1894 and now numbers over three hundred members. Ten new members were elected at this meeting and eight applications for membership were received.

The following is a list of the papers presented, many of which will be published in the *Transactions of the Society*, others in the *American Journal* or the *Annals of Mathematics:*

'Note on relative motion,' Dr. A. S. Chessin, New York, N. Y.

'On surfaces of zero relative velocity and a certain class of special solutions in the problem of four bodies,' Mr. F. R. Moulton, University of Chicago.

'On the use of generalized differentiation in the solution of physical problems,' Professor John E. Davies, University of Wisconsin.

'A new class of link works,' Professor Arnold Emch, Kansas Agricultural College.

'A relation between point and vector analysis,' Mr. Joseph V. Collins, Stevens Point, Wisconsin.

'John Speidell's 'New Logarithmes,' Professor Florian Cajori, University of Colorado.

'On analogues of the property of the orthocenter,' Herbert Richmond, M.A., King's College, Cambridge.

'A theorem on skew surfaces,' Professor C. A. Waldo, Purdue University.

'Irrational covariant conics of a plane cubic,' Professor H. S. White, Northwestern University.

'On the generalization of Desargues' theorem,' Professor Frank Morley, Haverford College.

'On certain crinkly curves,' Professor E. H. Moore, University of Chicago.

'Note on non-quaternion number systems,' Dr. Wendell M. Strong, Yale University.

'On mixed groups,' Professor H. B. Newson, University of Kansas.

'The invariant theory of the inversion group,' Dr. Edward Kasner, Columbia University.

'Note on the imprimitive substitution groups of degree fifteen and on the primitive substitution groups of degree eighteen,' Miss Emilie N. Martin, Bryn Mawr College.

'A new definition of the general abelian group,' Professor L. E. Dickson, University of Texas.

'Definition of various linear groups as groups of isomorphisms,' Professor L. E. Dickson, University of Texas.

'On the groups of cogredient isomorphisms that are abelian,' Mr. W. B. Fite, Cornell University.

'On the groups that are the direct products of

two subgroups,' Dr. G. A. Miller, Cornell University.

'A proof that there are no simple groups of order 1440, 1512, 1680 or 1800,' Dr. G. H. Ling, Wesleyan University.

'On a relation between the totality of the elliptic functions and a line complex,' Dr. H. F. Stecker, Northwestern University.

'Geometric construction of the elliptic integral of the second kind, and of the Weierstrass sigma-function,' Dr. Virgil Snyder, Cornell University.

'Some applications of elliptic functions,' Professor Alexander Pell, University of South Dakota.

'On Fresnel's wave surface,' Dr. L. T. More, University of Nebraska.

Thomas F. Holgate,
Acting Secretary.

Evanston, Illinois.

THE WORK OF FOREIGN MUSEUMS.

The annual reports of several foreign Museums have been received during the summer months, and from them one may obtain a fair idea of the work they are doing, the support they receive and the disadvantages, mainly of lack of money and space, under which they labor. These reports comprise those of the Australian Museum (1897), Colombo Museum (1898), Museum Association of the Kingdom of Bohemia (1898), West Prussian Provincial Museum (1898), Castle Museum, Norwich (1898), Edinburgh Museum of Science and Art (1897), Corporation Museums and Art Galleries, Glasgow (1898), and Manchester Museum (1898–99). The first two institutions are government museums, the last four fall in the category of local museums, although that of Manchester, from its relations with Owens College, is on a somewhat different basis from the others. The Museum of Prag, and we believe the West Prussian Provincial Museums are, like various other European institutions, under the control of an association, although receiving a subvention from the state, to which they are responsible.

The Australian Museum leads the others in the matter of expenditures, although these only reach the sum of $35,000, and is doing much good work for the public in judiciously planned and well labeled exhibition pieces, and for science by constantly adding to its study series and publishing the results obtained therefrom. The usual complaint is made of lack of room and lack of force, but the completion of a new series of well-built and well-equipped workrooms is announced forming the basement of what will later on form a new wing to the Museum building. The most important publication was the memoir on the zoology of the Funafuti Expedition of 1896, but two parts of the 'Records' were also issued. The MS. for the two parts 'Accipitres and Striges' of the new edition of Dr. E. P. Ramsay's catalogue of birds is also ready. The number of accessions was 11,000, mostly gifts, and the number of visitors 122,894.

The Colombo Museum is practically prohibited from doing any work by the smallness of its appropriation, 24,000 rupees (about $8,000), as this does not suffice to fairly meet the running expenses, since we are told that the wood work is suffering for the lack of paint. This is to be deplored, for the Museum is well located for original work, is the official Museum of Ceylon, and is well attended by the public as is shown by the record of 111,000 visitors.

The activity of the Museum at Prag is shown by the numerous meetings of the various sections of the association by which it is controlled, while its collections have been extensively studied. The Director, Dr. Fric, gives some of the results of his studies in connection with his *Fauna der Gaskohle* and announces the completion of ten plates for that work. The expenses of the Museum amount to $24,000, a sum that

seems small in comparison with those of our own large museums; there is a special fund, *Matice Ceskā*, for the publication of scientific works in the Bohemian language, and another for the continuation of Barrande's great memoirs on the Silurian of Bohemia. There were 91,000 visitors and it is stated that of the Museum Guide Book, 555 copies in German were sold and 1,008 in Bohemian.

The report of the West Prussian Provincial Museum which, as its name indicates, is actively concerned with the history of that region including archeology, ethnology, and natural history, is mainly devoted to detailed accounts of the numerous accessions received by the different departments. These notices contain much information regarding the various objects, for example, noting the past and present range of the bear and wild boar, and describing and figuring various archeological specimens and the conditions under which they were found.

The Glasgow, Edinburgh and Norwich Castle Museums all include art galleries, and the report of the former relates to four distinct institutions. In all of these, science is necessarily more or less subordinated, playing the most important part perhaps in the Norwich Museum, and all are exhibition museums, none of them issuing any publications save guides to the collections. That of Norwich is particularly good and contains much information, especially in regard to the valuable local collection of birds. The attendance for these institutions was respectively 1,210,648; 770,807 of this being at 'The People's Palace,' 338,287 and 128,969.

The Manchester Museum is, if Mr. Hoyle will pardon the phrase, a very live Museum, and the report opens with a brief notice of the installation of the electric light. This was described at some length in the Report of the Museums Association of Great Britain, and comprises 162 incandescent and 44 arc lights, the latter of the inverted type and with the light reflected not downwards, but by means of a conical reflector upwards to the white ceiling. The most important acquisition has been the Dresser collection of birds, noticed in SCIENCE, and the most important publication, Mr. C. D. Sherborne's 'Index to the Systema Naturæ of Linnæus,' showing the place of every species name in the tenth and twelfth editions both as to genus and page. Mr. Sherborne is a believer in the 'law of priority' as applied to nomenclature and indicates his preference for making the tenth edition its starting point.

The number of gifts to these various museums, governmental or local, is noteworthy, since this is largely a test of the interest taken by the community in the welfare of the institution, but it is to be remarked that ethnological material is less freely given than any other. Finally three of the museums present us with figures bearing on the question of Sunday opening, and in each case the number of visitors on Sunday is much in excess of that on other days; thus in the Australian Museum, the average week day attendance was 341, that of Sunday 634, while in the Norwich Museum, the figures were respectively 396 and 706. At the Manchester Museum the attendance on week days ranged from 30 to 372 and on Sunday from 146 to 550.

F. A. L.

ROBERT WILHELM BUNSEN.

WITH the death of Bunsen there has passed away the last of those great German chemists of the middle of the present century, chemists who bore the greatest part of the work of laying the foundations of the modern science, and through whose efforts their fatherland has taken the first place in chemistry among the nations of the earth. The century began with Wöhler and Liebig; in the next decade came first Bunsen

and then Hofmann and Kolbe and Fresenius; perhaps to these we should add Kekulé, who followed ten years later. Wöhler brought to Germany the chemical power and intellect of the Swede Berzelius; Liebig the brilliancy of the French school, where Gay-Lussac, Vauquelin, Thénard, Dulong, Chevreul and other successors of the 'Father of Chemistry' were full of activity. Wöhler, at Göttingen, and Liebig, at Giessen, became the progenitors of the German school. Bunsen and Kolbe were Göttingen boys, Hofmann and Fresenius (and we might add Kopp) were born at Giessen, while Kekulé was a youth in Bunsen's laboratory. This band of men were not merely discoverers of chemical fact and theory; they were the discoverers of men. Hardly a chemist of note to-day in Germany or England or America, who has passed young manhood, but has felt the direct impress of one or another of these men. They have been the world's teachers of chemistry, and to-day how many teachers are using their personal recollections of these their own instructors to inspire the next generation of pupils.

And now the last of these giants is gone. Liebig was the first to be taken, just rounding out his three score years and ten. A decade later and Wöhler and Kolbe passed. The last ten years have seen the death of Hofmann, Kekulé, Fresenius and now, at the close of the century, a few months only before the hundredth anniversary of Wöhler's birth, Bunsen is dead.

The outward incident of Bunsen's life is quickly told. Robert Wilhelm Bunsen, the son of a distinguished theologian, was born at Göttingen, March 31, 1811. In 1831 he was graduated at the University of Göttingen as Ph.D., and after some study at Paris, Berlin and Vienna he was appointed *Privatdocent* and then assistant professor at Göttingen. In 1836 he succeeded Wöhler at the Polytechnic School at Cassel, and in 1838 was appointed professor of chemistry at Marburg. Here he remained for several years, went to Breslau for a short time, when he was called in 1851 to Heidelberg. Here he remained active till 1889, when he resigned from service; but he still retained all his old interest in the chemical laboratory. Sometime before resigning, he received a very urgent call to the University of Berlin, but he was unwilling to change his home in his old age. He died at Heidelberg, August 16, 1899. Few honors which fall to the lot of chemists but were bestowed upon him. In 1858 he was elected foreign member of the Royal Society; in 1883, one of the eight foreign associates of the French Academy of Sciences. He received from the Royal Society in 1860 its Copley medal, and in 1877 he and his associate Kirchhoff were joint recipients of the newly-founded Davy medal.

Bunsen was a broad chemist, confining his work to no one branch of the chemical field. He was equally at home in theory and in practice, and perhaps his most important work consisted in laying foundations on which others should erect the superstructure. He would hardly be called a prolific writer, and yet he is credited with more than a hundred articles, of most of which he was the sole author.

His first published work was in 1834 and consisted of a short note in the *Journal de Pharmacie* calling attention to the value of ferric oxid (hydrated peroxid of iron) as an antidote for arsenic poisoning. This was the beginning of his work on arsenic, from which he was to receive great reputation, but from which also he was to nearly lose his life. He could not have better shown his pluck and enthusiasm than by attacking the dangerous problem of the organic compounds of arsenic. It was a theme which has cost more than one chemist his life, but it was of great importance in Liebig's work on the 'radical theory.'

More than twenty years earlier Berzelius had said: "The application of what is known regarding the combination of the elements in inorganic nature, to the critical examination of their compounds in organic, is the key by which we may hope to arrive at true ideas with respect to the composition of organic substances." Bunsen followed up this idea, showing that the so-called *alkarsin*, $As_2(CH_3)_4$ was a radical, but a compound radical, being made up of arsenic an inorganic element combined with hydrocarbon radicals which are organic. This work of Bunsen's, though of course far less reaching in importance than Wöhler's then recent synthesis of urea, was far more difficult and dangerous, not only than this, but also than Liebig and Wöhler's investigations of the benzoyl radical and Gay-Lussac's study of the cyanogen radical. This work of these four chemists established for the time being the 'radical theory' which indeed was to be soon overthrown, but was later to reappear as a part of our theory of to-day.

At the time Bunsen was carrying on his researches on organic compounds of arsenic, he was beginning that series of investigations on the gases in the iron furnace, which culminated in the report presented to the British Association in 1845 by himself and Lord Playfair, on the 'Gases evolved from iron furnaces, with reference to the theory of smelting of iron.' While the utilization of the waste gases of the iron furnace for fuel had been attempted at a much earlier date, it was not till the work of Bunsen, alone and with Playfair, that the enormous waste in these gases was impressed upon ironmasters; so that Bunsen can be said to have largely contributed to this great source of economy in the modern furnace. In other directions also these investigations bore practical fruit.

The study of furnace gases had demanded methods of gas-analysis which at that time did not exist. Perfecting the old, originating new, Bunsen built up a system of methods of gas analysis which have remained the foundation of those subsequently used; indeed he has been called the founder of this branch of analytical chemistry.

In this connection should be mentioned the Bunsen burner, now universally used in chemical laboratories, and almost as extensively outside, as in the Welsbach light. The principle of mixing a proper amount of air with a combustible gas and burning it from an open tube is very simple—after it is known, but it was unknown until discovered by Bunsen.

In 1841 and 1842 Bunsen published his experiments on the use of carbon in the place of the more expensive platinum in the Grove battery. The outcome of this work was the Bunsen battery, which has been one of the most useful as well as the cheapest of all batteries, and which may be said to have refused to yield supremacy until displaced with all other batteries by the dynamo.

Having a powerful source of electricity at his disposal, he re-investigated the methods by which nearly fifty years before Davy had been the fortunate discoverer of so many new elements. Bunsen improved these methods, and made in connection with Matthiessen, the first thorough study of lithium, which had been discovered by Arfvedson in 1817, and for the first time the metal was isolated by him.

All through this period and for many years later he took great interest in mineralogical chemistry, especially in the chemistry of rock formation. In 1847 he visited Iceland, and soon after published a number of papers on the chemical geology of that island and also on the theory of geysers.

A series of investigations carried out with Sir Henry Roscoe, on photo-chemistry, laid the foundations of actinometry. The work of Daguerre and his followers had

just given birth to the art of photography, but the whole subject was up to this time empiric. By Bunsen and Roscoe it was placed on a scientific basis and the way blazed out for the many future investigators in this field.

One further study should be mentioned, that of Bunsen and Schischkoff on the theory of gunpowder. Gunpowder had been known for centuries; van Helmont had stated that its power was due to the production of gas, but beyond this little or nothing was known till these chemists took up the investigation of the gases formed and the powder residues, and formulated for the first time a theory of gunpowder. Here as in other cases the first incentive was given which resulted in the work of Karolyi and Abel and Nobel, and the many present-day workers in the field of explosives.

This *résumé* is but an outline of the more important work of this great chemist, during the first half century of his life. It was almost at the close of this half century that there was to come, as it were as a crown to his work, that great discovery with which the name of Bunsen will ever be most closely linked, spectrum analysis. For several years he had been interesting himself much in blow pipe analysis, and it seems probable that the key to this discovery came, not as a result of long and patient search, but rather grew from his daily work of laboratory instruction. It was the discovery of the teacher rather than of the investigator. Associating with him his colleague, Kirchhoff, together they worked out the practical application of his discovery, and science stood armed with a new weapon, the spectroscope. Bunsen was the first to avail himself of the instrument and brought forth from the waters of Dürkheim two new elements, rubidium and cesium. Later other new elements have followed, as indium discovered by Boisbaudran and thallium by Crookes, and a host of 'meta elements' differentiated only by the spectroscope, the latest of them, victorium, needing not only this instrument but also the camera, to render its 'lines' apparent.

But far more important than the mere discovery of new elements was the widening of man's horizon in a new and unexpected way. Spectrum analysis was applicable not alone to those flames we could place before it within the confines of our laboratories; the light of the sun and the stars could be studied equally well and a means was at hand for learning the chemistry of the heavenly bodies. Yet this was not all, for by the displacement of lines the motion of stars and other bodies in line of sight becomes known. Astro-physics is rendered possible by Bunsen's work.

The last of the great investigations of Bunsen were on calorimetry. The Bunsen ice calorimeter was described by him in 1870 and rendered possible specific heat determinations, with quantities hitherto too small for investigation. While from this time his activity was much lessened, yet now and then papers continued to appear from his pen. The last few years of his life, however, were spent in the quiet retirement of the old university town which had so long been his home. As long as he was able he took great delight in showing visitors over his old laboratory, and the writer will long remember a pleasant hour spent with the old man in his laboratory some years ago, how he showed the rooms and places where this or that historic work was done, and what a delightfully genial man he was to a young stranger.

As the old chemist's sun was sinking to the west there came to Heidelberg, like a brilliant meteor, one whose fame far outshone the older light. All things were changed, the old building passed, a new and magnificent laboratory took its place; again students flocked to the Neckarthal

for chemical study, but the discoverer of the spectroscope was almost forgotten. A few brief years passed by, and as the light of the brilliant meteor is suddenly extinguished, so Victor Meyer was no more. But still Bunsen lingered, as if loath that a single year of the century ushered in by his master Wöhler should be left without the presence of one of the giant minds of chemistry. But now he too is gone and the last link between the past and the present is severed as far as lives go; but upon the foundations laid by Bunsen many a superstructure will continue to rest, and yet many another building will be erected.

JAS. LEWIS HOWE.

WASHINGTON AND LEE UNIVERSITY.

SCIENTIFIC BOOKS.

Anatomie des Frosches auf Grund eigener Untersuchungen. By A. ECKER und R. WIEDERSHEIM, durchaus neu bearbeitet von DR. ERNST GAUPP. Zweite Abteilung, Zweite Hälfte. Lehre vom Gefässsystem. Braunschweig, 1899, pp. XII. and 237–548.

Some time ago (this JOURNAL, Vol. VII., p. 463) we had occasion to notice the first and second parts of Gaupp's edition of Ecker on the frog, and now the third part of the same work lies before us. This part is devoted solely to the anatomy of the vascular system and here, as in the sections devoted to the skeleton, muscles and nerves, we find what is practically a new treatment, and not merely a revision of an old work. Not only has every page been rewritten, but every illustration has been redrawn, and most of them are printed in colors, adding not a little to the clearness.

It is impossible to summarize these 312 pages nor to point out what is new in them, for that would require more space than we can give. As one would naturally expect, the additions and changes are less in the parts relating to the arteries and veins, but even here they are numerous. The heart is described with far more accuracy and detail than ever before. It is, however, in the lymph system that the changes are the greatest. In fact, this section is almost wholly a new investigation. In the former editions there was a brief account of the lymph-hearts and of some of the sub-cutaneous lymph-sacs and that was all. Dr. Gaupp has studied not only all of these (he has added four subcutaneous lymph sacs not recognized before), but he has described with the greatest detail the lymph spaces which are scattered through the body and has made out the openings by which they communicate with one another.

As we turn over the pages of the work we wonder what the technique has been and many may be glad to learn his methods. For injections of the arterial system he found that shellac solutions were most useful, while for the venous system he depended largely upon natural injections, the blood settling in these vessels. To aid in this the animals were hung in various positions so that the blood might flow into the various portions. Then a transfer to formalin produced coagulation. A similar coagulation of the lymph as well as the well-known method of inflation with air aided in the demonstration of the lymph sacs and spaces; while the communications between these (minute openings in the thin and almost transparent membranes) were rendered visible by means of absolute alcohol and weak solutions of iodine.

In conclusion we may say that we have only praise for this part of the work, and that, while in a few places we find differences from conditions which occur in our American frogs, we find nothing that we can regard as serious errors. The probabilities are that it will never be translated, but it is a treatise which should be on the shelves of every laboratory. The clear and simple German in which it is written will make its contents easily accessible to the great majority of our college students. The concluding part dealing with the viscera, integument and sense organs, is promised shortly.

J. S. KINGSLEY.

The Fixation, Staining and Structure of Protoplasm, a Critical Consideration of the Theory and Technique of Modern Cell-study. By DR. ALFRED FISCHER (Leipsic), royal octavo, 362 pages, 1 double plate and 21 figures in text. Published by G. Fischer, Jena, 1899.

The history of the closing cycle of botanical

activity will undoubtedly show that one of its most noticeable and unusual features has been the enormous amount of energy devoted to the study of the structure of protoplasm. Research in this phase of biological science may be said to have had its origin chiefly in an effort to determine the mechanism of the nucleus as a vehicle of heredity, and it has been directed for the greater part to the morphology of the chromatin in mitotic division, and to the behavior of the 'attractive and directive bodies,' with some effort to take into consideration the structure of protoplasm and the general organization of the cell. The results of these investigations have filled a great amount of space in all classes of botanical Journals, beside the special periodicals devoted to the subject, and have covered an untold area of the costliest plates. The early specialization of a large number of the younger workers in this line has led to the publication of many articles on the subject utterly devoid of literary form, filled with local and personal terms, uselessly recounting technique, and giving the most merciless repetition of details of observation with no attempt to summarize the results, or give the general significance of the phenomena described: making the preparation of such a work as the book under discussion doubly necessary.

Then again the time seems at hand when the cytologist may be fairly asked to interpret to his botanical brethren the vast amount of detail accumulated in the last decade by his method of research. So far as the general discussions of recent date may be taken as a reply to this pertinent inquiry, the summary of well-grounded facts and established theory shows a very small residuum of actual progress. Thus one of the most prominent cytologists in America has taken occasion to say, in a recent review of knowledge of the cell, "And yet if we take account of the actual knowledge gained, we can not repress a certain sense of disappointment, partly that microscopical research should have fallen so far short of giving the insight for which we had hoped, but still more because of the failure of the best observers to reach any unanimity in the interpretation of what is actually visible under the microscope. * * * I would like at the outset to express the opinion that, if we except certain highly specialized structures, the hope of finding in visible protoplasmic structure any approach to an understanding of its physiological activity is growing more, instead of less remote, and is giving way to a conviction that the way of progress lies rather in an appeal to the ultra-microscopical protoplasmic organization, and to the chemical processes through which this is expressed." (E. B. Wilson, in SCIENCE, p. 34, July 14, 1899.)

The chief value of the book at hand consists in its collation of the methods used, and facilitates the ready selection of those which give promise of results in new methods of attack.

In Part I. the reaction of the more important chemical constituents of the cell to fixing agents is discussed, and the principles evolved must be considered as valuable when used as a means of chemical analysis of the cell. Part II. takes up in detail the methods and theory of staining. Chromatin is defined as the substance which contains nucleic acid and which as the acid content increases, stains less deeply with watery solutions of acid colors, and methyl green is designated as the only basic stain for nuclear substance. The chapters on this subject should do much to give a more intelligent development of the technique of staining, though it is to be feared that such terms as 'acidiphobie,' 'basiphobie,' 'eosinophilie' and 'fuchsinophilie' will be transplanted bodily into the English text by that class of workers who seem unequal to the translation of new terms, or the suppression of those unnecessary to the real advance of the subject. Astral rays and polar spindles come in for their share of attention in Part III., the chief methods of forming artificial radiating processes are given. The discussion of the histology and development of these structures is notable for its omissions, which are further reflected in the bibliographical list. The consideration given centresomes illustrates quite clearly the fragmentary and contradictory state of our information concerning the morphology and physiology of these bodies.

The concluding part of the work is taken up with a consideration of the various theories as to the structure of protoplasm, an adduction of the views of most of the principal workers, and

the description of the experiments for the production of artificial protoplastic formations.

It is to be said that this book of Dr. Fischer's comes most timely to aid the beginner, or the worker in other lines of investigation to orient the vast body of detail which has been presented in such confusion during the last decade, and it may also do much to put research upon the included subjects on a more rational basis.

D. T. MACDOUGAL.
NEW YORK BOTANICAL GARDEN.

A Class-book of (Elementary) Practical Physiology. By DE BURGH BIRCH, Professor of Physiology in the Yorkshire College of the Victoria University. Philadelphia, P. Blakiston's Son & Co., 1899. Pp. xii + 273.

This book is one of that considerable class of laboratory guides which are prepared for individual laboratories. While fairly good of its kind, it cannot readily be adapted to general use. This is more particularly true of the experimental section, where the directions to the student frequently have reference to specific appliances which, in the form here described, are not to be found in physiological laboratories generally. The course outlined is that which is so commonly denominated Physiology in the British colleges, and consists of histological, chemical and experimental sections. The first section comprises 117 pages, the second 61, and the third 87. The method employed is that of supplying the student with detailed directions, leaving comparatively little opportunity for the play of his ingenuity. This method, while making instruction easy for the instructor, does not develop the student. It is carried to its extreme in dealing with the direct method of using the ophthalmoscope: "First, with the apertures closed, endeavor to look into the eye through the lens, moving your eye and a light in all directions to do so. You will not succeed." If success is impossible, why deliberately guide the student in that direction?

Not a large amount of ground is covered by the book. The subjects and experiments that are presented are the conventional ones, and the work is intelligently done. The book, however, hardly seems to be called for outside the author's own laboratory. FREDERIC S. LEE.
COLUMBIA UNIVERSITY.

Elementary Physiology. By BENJAMIN MOORE, M.A., Professor of Physiology in the Medical Department of Yale University. New York, Longmans, Green & Co., 1899. Pp. viii + 295.

The majority of the briefer text-books of physiology are not written by physiologists. They are the work of men who rely upon larger text-books for their knowledge, and whose motive too often is the money to be obtained from the text-book mongers. Too many of these authors are willing, for a consideration, to prostitute the science for commercial purposes, and to write it down to the level of those who appear to believe that an account of the working of the human body, and a description of the awfulness of a drunkard's life, are synonymous. It is a relief and pleasure to turn from such machine-made books to such a one as Professor Moore's, and to feel the loving interest that every page of the book reveals. One can forgive the occasional lapses from strict rhetorical usage, the not infrequent long sentences, and the rather indiscriminate and often misleading use of commas, when one realizes that the author knows his subject and writes entertainingly of it.

The book is devoted to the physiology of man and those animals that are allied to man, and in less than three hundred pages there is given a concise and very readable outline of the subject, an appendix of practical exercises and a set of test questions. The trend of the author as a physiologist is evidenced by the fact that nearly one-half of the book is devoted to nutrition, including the blood and its circulation, digestion, absorption, metabolism, respiration, excretion and animal heat. In an unprejudiced division of the subject of human physiology, this seems too large a proportion, although it must be granted that the account of these processes is an admirable one. Forty-three pages seem also too large a share to give to the skeleton and its articulations. In general, the amount of anatomy may be criticised as excessive; but throughout this the author keeps in mind the subject of function and thus illuminates his descriptions of structure. Furthermore, one-sixth of the whole space is a small proportion to devote to the nervous sys-

tem and the special senses. It is to be hoped that before issuing a second edition, which will probably be called for, the author will re-apportion his space and develop more fully these latter subjects.

The book is fully up to date in its facts. As to point of view it represents, like nearly all text-books of the physiology of man, that of conventional or organ physiology, rather than that of the cell.

FREDERIC S. LEE.

COLUMBIA UNIVERSITY.

Analyses Electrolytiques. Par AD. MINET. Masson et Cie, Paris.

The first three pages of the first chapter of this little volume aim to be historical, but in the latter respect are so incomplete that they are really misleading. The subsequent pages, devoted to the sources of electricity, the measurement of current intensity, a description of the different apparatus used in electrolytic analysis and electrolytic constants, are much more satisfactory and really praiseworthy.

The second chapter pretends to consider electrolysis from a qualitative standpoint, but is so meager in its details that that feature of it would probably have better been omitted. The quantitative determination of non-metals (the halogens, nitrogen in nitrates and sulphur in sulphides) is also considered.

The third chapter relates to the quantitative determination of individual metals. In the main the procedures are similar to those already described in existing works upon electrochemical analysis. There is no good reason to omit the double cyanide of mercury and potassium in speaking of proper electrolytes for the determination of that metal. Under iron reference is made to the 'Procede de Drow,' meaning of course our own Dr. Drown. The author seems to have been careless in regard to the correctness of names, for there are numerous oversights of this character scattered throughout the entire book. At times there seems to have been an effort made to give due credit to the various workers in this particular field, but oftener there is an absolute neglect as to the origin of the methods.

Had M. Minet ever tried the separation of copper from silver electrolytically, the reviewer sincerely doubts whether he would have recommended the suggestion given on page 134. Those experienced in this direction know that to precipitate out the silver as oxalate, wash it, etc., is a vexing operation. Why not simply add an excess of alkaline cyanide to the solution of the two metals and electrolyze at 65°C? The separation is then complete and rapid. Other methods are not above criticism, but it is not the purpose of the reviewer to find fault. His sole desire is to see the best given to those who may undertake to do work in this field.

The fifth chapter gives in considerable detail the work of Hollard in the application of electrolytic methods to the analysis of alloys, and is very meritorious in every respect. One hundred and seventy-six pages comprise the entire volume, which no doubt will serve well to give one, not especially interested or conversant with this field of investigation, a very good idea of what is being done, but the writer questions whether more than that can be fairly claimed for this publication.

EDGAR F. SMITH.

BOOKS RECEIVED.

Observations taken at Dumraon Behar, India, during the Eclipse of the 22d of January, 1898. REV. V. DE CAMPIGNEULLES. New York, London and Bombay. 1899. Pp. xi + 194 and thirteen plates.

The North American Slime-Moulds. THOMAS H. MACBRIDE. New York and London, The Macmillan Company. 1899. Pp. xvii + 231 and eighteen plates. $2.25.

Social Laws, an Outline of Sociology. G. TARDE, translated by HOWARD C. WARREN. New York and London, The Macmillan Company. 1899. Pp. xi + 213.

Darwinism and Lamarckism. FREDERICK WOLLASTON HUTTON. New York and London, G. P. Putnam's Sons. 1899. Pp. x + 226.

SCIENTIFIC JOURNALS AND ARTICLES.

UNDER the administration of Dr. von Ihering, the Museum of Sao Paulo, Brazil, is accomplishing much scientific work while at the same time rapidly enlarging its study and exhibition collections. The third volume of its *Revista*, contains a posthumous paper by Dr. Fritz Mueller on the 'Marine Fauna of the Coast of Santa

Catherine,' descriptions of new Coccids, by T. D. A. Cockerell and A. Hempel, and 'Contributions to our Knowledge of the Spiders of Sao Paulo,' by W. J. Moenkhaus. A. S. Woodward describes several new fishes from the bituminous schists of Taubaté, interesting from the fact that they belong to existing genera, and Ricardo Krone gives an account of 'the Limestone Caves of Iporanga.' The major part of the volume is devoted to a systematic list of 'the Birds of Sao Paulo,' by Dr. von Ihreing, intended as a working basis for the study and discussion of the ornithology of that State. Dr. von Ihering admits 590 species. An alphabetical index of the common names is appended which should be of good service to those interested in the avifauna of Brazil. The volume closes with a bibliography of current works on natural history and anthropology relating to Brazil. Dr. von Ihering records the finding of a dead specimen of *Spheniscus magellanicus* on the coast of the island of Santo Amaro off the coast of Brazil, in about latitude 24° S. A previous example was taken still farther north at Sao Sebastiao island, 23° S.

American Chemical Journal for September, 1899, contains the following articles:

'On alkyl malonic nitriles and their derivatives,' by J. C. Hessler.

'On the phenylhydrazones of benzoin,' by A. Smith.

'Thermal effects of the dilution of some salts,' by F. P. Dunnington and T. Hoggard; 'Preservation of Hübl's reagent,' by R. Bolling; 'Dehydration of crystals of sodium phosphate,' by T. C. Whitlock and C. E Barfield.

'Examination of a Sandstone from Augusta County, Virginia,' by W. W. Miller, Jr.

'Solubility of lead sulphate in ammonium acetate,' by J. C. Long.

'Analysis of Smithsonite from Arkansas,' by W. W. Miller, Jr.

'Desulphones and ketosulphones,' by E. P. Kohler and Margaret B. MacDonald.

'The reaction between sulphone chlorides and metallic derivatives of ketonic esters,' by E. P. Kohler and Margaret B. MacDonald.

J. E. G.

The Osprey for September opens with a brief article on 'Familiar Birds of Honolulu,' by Milton S. Ray, followed by 'Eight Days Among the Birds of Northern New Hampshire,' contributed by John N. Clark, and dealing mainly with the nesting habits of the many species observed. Four short papers deal mostly with various warblers and then, under the head of Notes for 'Observation of Habits of Birds,' Ernest Seton Thompson gives a list of the points that should be particularly noted. F. H. Knowlton and W. F. Henninger contribute letters on the question of excessive egg collecting. Numerous interesting notes and reviews of current literature complete the volume.

THE only scientific and philosophical articles which appear in the October *Monist* are: (1) 'Psychology and the Ego,' by Professor C. Lloyd Morgan, Bristol, England; (2) 'The Man of Genius,' by Professor G. Sergi, Rome, Italy; and (3) 'A Decade of Philosophy in France,' by Lucien Arréat. The remainder of the contents is devoted to a discussion of the Bible, by Professor C. A. Cornill, of Breslau, Germany, Dr. W. Henry Green, of Princeton, N. J., and Dr. Paul Carus.

Appletons' Popular Science Monthly for October, completing its fifty-fifth volume, has as a frontispiece a portrait of the late William Pepper, and includes an article narrating his great activity for the public institutions of Philadelphia and especially the University of Pennsylvania. The number contains an account of the Columbus meeting of the American Association, by Professor D. S. Martin, and a number of other articles including two on the administration of charities, by Bishop Potter and Comptroller B. S. Coles.

SOCIETIES AND ACADEMIES.

THE WASHINGTON BOTANICAL CLUB.

THE eighth regular meeting was held August 2, 1899, a paper by Dr. Gerrit S. Miller, of the U. S. National Museum, on the species of *Apocynum* occurring within the District of Columbia, was presented by Mr. Pollard. Dr. Miller recognizes three new species in addition to the already known *A. androsæmifolium* L., *A. cannabinum* L., *A. medium* Greene and *A.*

album Greene. The paper was illustrated by herbarium material and by samples of the flowers of each species preserved in formalin. While the main characters lie in the shape of the calyx and corolla tube, the habit and foliage of the plant afford good diagnostic points.

Mr. O. F. Cook discussed certain new or little known species of *Amanita*, commenting on their structure and relationships.

The ninth regular meeting of the Club was held September 6, 1899, and was devoted to an informal account of the Alaskan flora by Mr. Frederick V. Coville, who was a member of the Harriman expedition.

CHARLES LOUIS POLLARD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ON THE DEFINITION OF GEOLOGICAL TERRANES.

SURPRISING as it may seem to those who are not professional geologists, it nevertheless with truth may be said that until within the last decade or two there existed little demand for the concise definition of geological terranes and formations. The mere application of a name was almost enough to establish it. In this connection there was often also an enumeration of the common fossils contained, or a somewhat generalized vertical section of the rock layers. One or the other of these features and a knowledge of the typical locality at which the rocks were exposed often enabled the terrane to be subsequently recognized and the title to be used.

At the present time all is changed. With the systematic introduction of local geographic names for the geological terranes, and the general adoption of criteria of discrimination other than those afforded by fossils, there has come to exist an urgent need for more accurate definition of terms. The degree of accuracy now demanded is comparable to that attained in other branches of science. The requirement is for definition based not on trivial or accidental characters, but upon features that are not only really determinative, but recognizable in the field.

The classes of characteristics that require attention are not many, yet in the description of geological terranes it rarely happens that any of these features are clearly pointed out, or when mention is made of them that they are equally compared. When a new name of a rock terrane is formally proposed, about the least thing that its author can do, if he wishes his term to be considered by his fellow workers, is to tabulate the leading characteristics and differences as compared with associated terranes.

In the past there has been little or no necessity for very exact discrimation; hence in using the title suggested by the workers of a generation or more ago we have to do the best we can, giving the pioneers the benefit of all doubts. When titles are applied to terranes now there is cogent demand for formal enumeration of essential features.

Exactly what should constitute a proper definition of a geological terrane may give rise to some differences of opinion. But there should be no variance of views regarding what points should be especially mentioned. Little or no attempt has yet been made to formulate these groups of essential characteristics. They appear, however, to fall naturally under six categories, which may be termed: (1) geographic distribution, (2) topographic expression, (3) lithologic nature, (4) stratigraphic delimitation, (5) biologic definition, and (6) economic content.

1. *Geographic Distribution* is of first importance, as it fixes the terrane in space. The actual area occupied, or the amount of territory over which it forms the surface rock, is largely a function of the present attitude of the rocks. When the beds are horizontal, or nearly so, the surface distribution closely coincides with the original lateral extent. The area occupied is broad. As the degree of tilting increases, owing to orogenic movement that took place after the sediments were laid down, there is a narrowing of the zone until, when the strata stand vertically, it reaches a minimum breadth.

In the definition of a geological terrane the matter of geological distribution is not only of much greater import than it was formerly supposed to be, but it is a factor that is constantly becoming more valuable for the reason that rock units are now being named after

prominent geographic features that are situated within their borders.

2. *Topographic Expression.*—While the surface relief, or topographic expression, of various regions has received more or less consideration in the past, its great variety and characteristic types have been only vaguely connected with the structure and composition of the underlying rocks. Only recently has the interpretation of topography found a philosophical foundation. Only within the last few years has arisen a entirely new department of geological inquiry. The rapid development of this new science of geomorphy, or geographic geology, has given a new meaning to stratigraphy, and therewith has furnished a reliable criterion for determining and mapping geological formations that was wholly unthought of before. General topographic expression may be now regarded as one of the most important and distinctive attributes of geological terranes.

When its topographical type and peculiarities are clearly discerned a terrane may be, with frequent checks from other sources, traced many miles with rapidity and certainty, from horseback, or often even from the swiftly moving railway train.

As the differences in the topography of a region are dependent primarily on the relative power of resistance to erosion that the several contiguous layers possess, there is usually a close relationship existing between this feature and the other characteristics which have been heretofore generally considered alone in connection with stratigraphy. Thus, an extensive shale bed will often be worn down to a lowland plain, while the limestone or sandstone strata on either side of the belt will form ridges. The faunas in shales are usually peculiar to them, and very distinct from lithologically different beds. Again, a limestone which forms the hard member with the soft shales is, when intercalated with crystallines, itself the soft member and constitutes the valleys.

Although the same kinds of beds may produce directly the opposite phases of topographic expression, for each particular region the phase assumed is distinctive and generally extends throughout the geographical extent of the terrane.

3. *Lithologic Nature.*—In the early part of the century it was customary to regard lithological characteristics as the most important features in the recognition of geological formations. In correlating deposits more or less widely separated, this character was depended upon, to the exclusion of all others. At a later date, when other criteria were applied, the determinations which had been made upon purely lithological grounds were found to be so faulty and unreliable that the use of this feature finally came to be ignored almost altogether. Of late, the real value of the lithologic factor is beginning to be more fully appreciated. It is certainly as trustworthy as the faunal characteristics of a terrane, and, in addition, is generally of wider application.

The lithology of a geological formation, outside of the massive rocks, is largely a function of the attitude of the adjoining land areas at the time that the beds were laid down. Hence, there is a close connection between the local character of the forming strata and the position of the adjacent land as changing under the influence of diastatic movement. In noting the distinguishing characters of a terrane the lithology should receive the fullest consideration and the most careful discrimination.

4. *Stratigraphic Delimitation.*—Until very recently little attention has been paid to the exact vertical or range limits of geological terranes. In an indefinite and incidental way they have been often fixed within narrow bounds, and the local features explained for the typical locality; but farther than this most descriptions are stratigraphically inexact.

The determination of definite, easily recognizable upper and lower horizons, that are readily traceable over considerable areas, are of prime importance, not only to have a compact, natural unit, but on account of presenting reliable features for the correlation in different parts of the geologic province. The division line between terranes is not always equally distinct and prominent throughout the areal extent of the deposit, and different criteria have often to be resorted to in different parts of a province.

While the exact position of a terrane in the general geological scale is not always to be made out with exactness at first, its approxi-

mate equivalents in well-known sections may be pointed out. The exact location in the general vertical section of the region in which it lies must, of necessity, be determined sufficiently near to enable future recognition.

5. *Biologic Definition.*—The value of the fossils contained in a terrane varies greatly with the size of the succession of strata considered. The rapid replacement of faunas in local successions enables a number of zones to be made out, each of which is characterized by certain forms which predominate. From the purely paleontological standpoint this enables the strata to be subdivided in great detail. However, the real geological relations of the terranes are lost sight of almost entirely. Without going into details, there are ordinarily certain characteristic faunal or floral phases which constitute important features by which terranes may be distinguished from one another, or which, at least, greatly aid in this determination, especially when taken in connection with the criteria. Each terrane may be regarded as possessing biotic characters which should be clearly set forth.

6. *Economic Content.*—In the practical delimitation of a geological terrane, and in tracing it over a considerable area, the ore or mineral deposits of commercial value that are contained form valuable determinative factors that are rarely taken into consideration ; or, at least, in the descriptions of formations little note is ordinarily made of them. While with many, if not most terranes, the contained ores are not original depositions, but are secondarily acquired long after the rocks in which they occur were laid down, they are, nevertheless, of such peculiar organization and composition that they are seldom found either in the layers above or below. Furthermore, a rock terrane may be traced for long distances by the occurrences of valuable deposits along the line of the outcrop, or it may be recognizable by these alone over broad areas in which other characters of the terrane give no evidence of its existence. In correlating exposures somewhat widely separated, it is often only through the economic contents that a reliable clue is given to their identity.

CHARLES R. KEYES.

ZOOLOGICAL NOTES.

THE collection of birds formed by H. E. Dresser and constituting the basis for his work on the 'Birds of Europe and Monographs of the Rollers and Bee-Eaters' has been presented to the Manchester Museum, England, by a friend who wishes to remain anonymous. Something over 1,000 species are represented, by about 10,000 specimens, illustrating differences of plumage due to age, sex and locality, all carefully labelled.

HITHERTO the turkey buzzard has pursued a peaceful, if malodorous existence, unharmed by the whims of fashion, but this quiet has been disturbed by the present demand for eagle feathers for ladies hats. The supply of eagles is not equal to the demand, and as Ulysses is said to have eked out the skin of the lion by using that of the fox, so dealers substitute the primaries of the turkey buzzard for those of the eagle.

THE last report of the Royal Zoological Society of Amsterdam commemorates the sixtieth year of its existence and briefly reviews the more important events in its career. Besides the well-known zoological garden the society maintains a fine aquarium, zoological museum, museum of paleontology and geology, ethnographical museum, and library, a combination which affords fine facilities for scientific work. It will be remembered that Fürbinger's monumental work on the morphology of birds was among the publications of this society. The amount of food consumed by the animals is rather appalling, but the long list of members which closes the report shows the abundant resources of the Society. The 'sport mania' is deplored as being largely responsible for the extermination of large mammals, and, among other items, it is noted that no less than fourteen African elephants were born in the gardens.

F. A. L.

RECENT ZOO-PALEONTOLOGY.

DR. MAX SCHLOSSER, of Munich, contributes to a recent number of the *Palæontographica* a very important article upon the origin of the bears. Setting aside the generally accepted hypothesis of Gaudry, that *Ursus* sprang from *Hyænarctos* and that from *Amphicyon*, he traces

the origin of the *Ursidæ* back to the Oligocene. He places *Hyænarctos*, which first appears in the Upper Miocene, as a side line which died out in the Pleistocene. The Oligocene bears are traced back to animals related to *Cynodon* in the Upper Eocene and hypothetically to *Uintacyon* of North America. This paper is of enhanced interest in connection with the recent investigations of Wortman upon the origin of the dogs, published in a recent Bulletin of the Museum of Natural History, in which *Uintacyon* also figures. One feature of Dr. Schlosser's paper is the complete adoption of the Osborn and Scott nomenclature for the cusps of the molar and premolar teeth.

DR. JAMES P. HILL, of the University of Sydney, New South Wales, has followed up his discovery of the allantoic placenta in *Perameles* by the study of the female urogenital organs in the same type. This typical bandicoot is found to differ wholly in the structure of these organs from other Marsupials. These differences sustain Dr. Hill's original interpretation of the allantois of the Marsupials as a primitive organ characteristic of the stem Marsupialia, which most types have lost. To quote from his paper: "In concluding for the present this short discussion, I would remark that the facts here briefly set forth, in my opinion, show conclusively that the condition of the genital organ in macropods—undoubtedly one of the most specialized families in living Marsupials—can in no sense be regarded as primitive, and that just in so far as the genital organs of *Perameles* depart from the prevalent Marsupial condition they in the same degree realize the more primitive type. Indeed, the urogenital organs of the *Peramelidæ* appear, so far as I am able to judge, to have retained a more archaic condition than those of any other hitherto described Australian Marsupial, a conclusion which I believe gives very material support to that view which regards the existence of an allantoic placenta in the genus *Perameles* as an extremely primitive feature in its organization.

UNDER the direction of the American Philosophical Society has just appeared a joint paper by the late Professor Baur and Dr. E. C. Case, entitled 'History of the Pelycosauria, with a description of the genus Dimetrodon Cope.' This reminds us afresh of the great loss Paleontology has sustained in this country, and in fact everywhere, in the death of Georg Baur. This memoir is a fine example of the thoroughness of his work, giving us an exhaustive review of the Permian types the world over, which are remotely related to the living genus Sphenodon. This is also by far the most thorough *résumé* of the literature relating to the order termed by Cope the Pelycosauria. The memoir concludes by an original description of the great finned-back lizard *Dimetrodon* by Dr. Case. The only regret one feels in connection with this memoir is that the critical section is obviously left incomplete, since it lacks a clear expression of the authors' views as to the ordinal classification of the Permian reptiles.

H. F. O.

INTERNATIONAL CONGRESS OF PHYSICS.

The preliminary announcement of the congress is as follows:

La Société française de physique a pris l'initiative de provoquer, à l'occasion de l'Exposition universelle de 1900, une réunion en Congrès international de toutes les personnes qui s'intéressent aux progrès de la physique. Il n'est pas besoin de faire ressortir les avantages considérables que l'on est en droit d'attendre, au profit de la science, d'une telle réunion ; jusqu'à présent des congrès spéciaux, tels que les congrès d'électricité, ont conduit à des résultats que tous les physiciens connaissent et apprécient, mais jamais encore n'a eu lieu un congrès international consacré à la Physique générale ; il est permis d'espérer que cette première réunion présentera un grand intérêt.

Un Comité d'organisation a été constitué, qui a décidé que le Congrès international de physique s'ouvrirait le *lundi 6 août 1900*, et durerait une semaine. Le Congrès sera rattaché à l'ensemble des Congrès rentrant dans l'organisation de l'Exposition universelle ; la séance d'ouverture aura lieu au Palais des Congrès.

Il n'a pas semblé au Comité que l'on dût, dès à présent, fixer d'une façon définitive le programme des travaux du Congrès ; nous avons l'honneur de vous soumettre un projet

sur lequel nous serions très heureux de recevoir vos observations.

Le programme comporterait trois parties :

1° Rapports et discussions sur des sujets en nombre limité et arrêtés à l'avance, tels que : *a*, Définition et fixation de certaines unités (pression, échelle de dureté, quantité de chaleur, grandeurs photométriques, constantes de la saccharimétrie, échelle du spectre, unités électriques on encore définies, etc.) ; *b*. Bibliographie de la physique ; *c*. Laboratoires nationaux ;

2° Visites à l'Exposition, à des laboratoires, à des ateliers ;

3° Conférences sur quelques sujets nouveaux.

La Commission d'organisation recevra avec reconnaissance toutes les observations et propositions qu'on voudra bien lui adresser, elle fixera ensuite et vous fera connaître le programme définitif des travaux.

Le prix de la carte du Congrès sera de 20 francs, elle donnera droit :

1° A la participation à tous les travaux, à toutes les assemblées, à toutes les visites qui seront organisées ;

2° A la réception du compte rendu des travaux du Congrès, aussitôt après la publication.

Lorsqu'un membre du Congrès y viendra accompagné d'une ou plusieurs personnes de sa famille, celles-ci pourront recevoir, sur demande, des cartes spéciales à un prix réduit qui sera ultérieurement fixé.

Nous vous ferons connaître en temps utile les conditions spéciales de faveur que les compagnies de transport accorderont à l'occasion de l'Exposition universelle.

Il est nécessaire que le Comité soit, dès à présent, renseigné sur le nombre probable des membres du Congrès de 1900. Nous ne croyons point cependant pouvoir vous demander si longtemps à l'avance une résolution ferme, mais nous insistons d'une manière toute particulière pour que vous ayez l'obligeance de nous renvoyer, après l'avoir affranchie et après avoir rayé l'une des deux formules, la carte postale que vous trouverez ci-incluse :

Il est probable que j'assisterai au Congrès de Paris (avec . . . personnes de ma famille).

ou :

Il n'est pas probable que j'assiste au Congrès de Paris.

Ceci ne vous engagera en rien, à aucun point de vue, ni dans un sens ni dans l'autre ; cependant les communications ultérieures ne seront adressées qu'aux personnes qui auront envoyé la première réponse.

Toutes les communications devront être adressées : á M. Ch.-Ed. Guillaume, physicien du Bureau international des poids et measures, secrétaire pour l'étranger, au *Pavillon de Breteuil*, *Sèvres* (*Seine-et-Oise*), ou à M. Lucien Poincaré, chargé de cours à l'Université de Paris, secrétaire pour la France, 105 bis *boulevard Raspail*, *Paris*.

Veuillez recevoir, M. l'assurance de nos sentiments les plus dévoués.

Le Président du Comité d'organisation,
CORNU,
Membre de l'Institut.

Les Secrétaires :

Ch.-Ed. GUILLAUME,
au Pavillon de Breteuil, Sèvres (Seine-et-Oise) ;
Lucien POINCARÉ,
105 *bis*, boulevard Raspail, Paris.

P.-S.—1° Nous vous serions particulièrement reconnaissants de vouloir bien communiquer la présente circulaire à toutes les personnes qui s'intéressent à la physique.

2° Nous prions MM. les Directeurs des journaux scientifiques de vouloir bien reproduire, au moins par extraits, la présente circulaire, et nous les remercions d'avance du concours qu'ils voudront bien nous prêter.

COMMISSION D'ORGANISATION.

BUREAU.

Président :

M. Cornu (Alfred), membre de l'Institut et du Bureau des longitudes, professeur à l'Ecole polytechnique.

Vice-Président :

M. Cailletet (Louis-Paul), membre de l'Institut.

Secrétaires.

MM. Guillaume, attaché au Bureau international des poids et mesures.

Poincaré (Lucien), chargé de cours à la Sorbonne.

MEMBRES.

MM.

Dr d'Arsonval (Arsène), membre de l'Institut et de l'Académie de médicine, professeur au Collège de

France, président de la Société internationale des électriciens.

Le général BASSOT, membre de l'Institut et du Bureau des longitudes, chef du service de géodésie et d'astronomie au Service géographique de l'armée.

BECQUEREL (Henri), membre de l'Institut, professeur au Muséum d'histoire naturelle.

BENOIT, directeur du Bureau international des poids et mesures.

BICHAT, professeur à la Faculté des sciences de Nancy.

BLONDLOT, professeur à la Faculté des sciences de Nancy.

CROVA, professeur à la Faculté des sciences de Montpelier.

JOUBERT (Jules), inspecteur de l'Instruction publique, membre du Comité consultatif d'électricite.

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MATHIAS, professeur à la Faculté des sciences de Toulouse.

PELLAT (Henri), professeur à la Faculté des sciences de Paris, directeur du bureau de vérification des alcoomètres au Ministère du commerce et de l'industrie.

POTIER (Alfred), membre de l'Institut, ingénieur en chef au corps des mines, professeur à l'École nationale supérieure des mines.

VIOLLE (Jules), membre de l'Institut, professeur au Conservatoire national des arts et métiers.

We are able to publish the above announcement through the courtesy of Professor Wolcott Gibbs, President of the National Academy of Sciences, to whom it was sent with the following letter:

PARIS, le 17, juillet 1899.

MONSIEUR LE PRÉSIDENT :

J'ai l'honneur de vous adresser, sous ce pli, la première circulaire relative au congrès international qui se réunira l'année prochaine à Paris, sous les auspices de la Société française de physique.

Ce congrès, qui aura lieu au plus beau moment de l'Exposition universelle, alors que d'autres réunions similaires attireront à Paris des savants du monde entier, offrira aux physiciens des sujets d'intérêt variés, et nous osons espérer qu'ils répondront très nombreux à notre appel.

A cette occasion, nous avons pris la liberté de nous addresser à vous, Monsieur le Président, pour vous prièr de vouloir bien porter notre circulaire à la connaissance de votre Académie, et d'attirer sur elle l'attention de vos Collègues.

Nous vous serions très obligés aussi, de nous indiquer la meilleure marche à suivre pour qu'aucun d'eux, parmi ceux qui s'intéressent à la physique, ne soit oublié dans les convocations. Nous pourrions, suivant vos indications, vous envoyer le nombre de circulaires que vous voudrez bien nous fixer, ou faire l'expédition directement aux adresses que vous nous communiquerez.

J'aurai l'honneur de vous adresser les circulaires ultérieures faisant connaître de plus près l'organisation du congrès et les questions qui y seront traitées, et au sujet desquelles votre avis nous serait dès maintenant très précieux.

Dans le cas où votre Académie enverrait des délégués au congrès, je vous serais très obligé de m'en communiquer la liste avant le 15 juillet 1900.

En vous remerciant d'avance pour le concours que vous voudrez bien nous prêter en cette circonstance, je vous prie d'agréer, Monsieur le Président, l'expression de ma considération la plus distinguée.

Pour le Comité d'organisation,

Le Secrétaire,

CH. ED. GUILLAUME.

MONSIEUR LE PRESIDENT DE L'ACADÉMIE, NATIONALE, WASHINGTON.

THE CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS.

THE Office of Experiment Stations of the United States Department of Agriculture has recently published a Bulletin (No. 28—revised), by W. O. Atwater and A. P. Bryant, entitled 'The Chemical Composition of American Food Materials.' The introductory pages give a brief *résumé* of the history of that portion of chemistry which pertains to the analysis of foods, especially American work of this nature. The different constituents of foods are defined and discussed. The methods of cutting up meats are explained and illustrated by diagrams showing the position of the different cuts in the live and dressed animal. The larger

portion of the Bulletin is devoted to the figures showing the chemical composition of the different articles of food. As a rule only maximum, minimum and average figures are given, but in a few cases the individual analyses are quoted.

The animal foods whose composition is given include the different cuts of beef, veal, mutton and pork; fish, shellfish, etc.; poultry, game, eggs and dairy products; canned meats, soups, etc.; sausages and other manufactured products. The foods of vegetable origin include flour, meal, etc.; bread, crackers and pastry; sugar and starch; fresh and canned vegetables; pickles and condiments; fruits, fresh and preserved; and nuts. Little information has hitherto been available concerning the composition of some of these foods, for instance, nuts.

The literature of the subject has been thoroughly gone over and the present compilation is based upon over four thousand analyses. Many of these were in out-of-the-way publications not readily accessible to students of the subject.

Such a compilation is useful to specialists and also to those interested in nutrition from a more practical standpoint. With the aid of these figures it is possible to compare one food with another as a source of nutrients. The food value of any dietary may be computed if the amount of different foods consumed is determined, and by comparing the dietary with commonly accepted dietary standards its relative value may be seen. Analyses of foods have accumulated very rapidly in recent years, and it is probable that many more will be made in the near future. This Bulletin is designed to serve as a reference book until it shall be superseded by a more extended compilation.

SCIENTIFIC NOTES AND NEWS.

Charles P. Daly died on the 19th of September in his 84th year. He had served forty-two years as Judge of the Court of Common Pleas in the city of New York, and twenty-seven years as Chief Justice, his legal decisions being regarded as of the highest authority, many of them establishing precedents in questions of international importance. He had a wide sympathy and knowledge in many subjects of art, literature and science, and a memory and facility which made him friends all over the world. He had been president of the American Geographical Society for thirty-six years, and honorary member of the Geographical societies of London, Berlin and Russia. He was largely instrumental in accumulating the fine library of the American Geographical Society, and in securing the endowment for its new home near the American Museum of Natural History of which he was also a member. He and Mrs. Daly were members of the Torrey Botanical Club, which they joined expressly in order to aid in the foundation of the New York Botanical Garden. It was largely due to their wide acquaintance with prominent and intellectual men and women that the gardens were incorporated and endowed, and they were among the first and most liberal contributors. As one of the managers of the garden, Judge Daly had an active interest in its work, being always ready with advice and contributions to aid any of its enterprises. His death, following within one week that of Cornelius Vanderbilt, deprives New York of two of its most liberal citizens, and scientific institutions of friends and patrons, whose like is seldom seen.

Admiral Walker, Professor Burr, of Columbia University, Colonel Haines and Colonel Ernst, of the Isthmian Canal Commission, have been abroad during the summer studying the plans and documents of the Panama Canal, at Paris, and examining the Kiel Ship Canal. They went later to England to visit the Manchester Ship Canal, and expected to sail from Southampton for New York on September 23d. The Commission will leave New York probably about the beginning of November for Colon, and will make a careful study of the Panama, Nicaragua and other routes.

As the daily papers report in great detail, Signor Marconi with several assistants, has arrived in America. He intends to report the yacht races for the newspapers, and afterwards to conduct experiments for the War and Navy Departments.

Professor A. W. Rücker, F.R.S., will deliver an address on the occasion of the distribution of medals at the Royal College of Science, London, on October 5th.

PROFESSORS WILLIAM LIBBEY and CHARLES McCLURE, members of the Peary Relief Expedition have returned to Princeton with valuable collections, both of vertebrates and invertebrates.

MR. W. D. HUNTER, special agent of the Division of Entomology, Department of Agriculture, has returned to Washington, after having studied the Turtle Mountain region in North Dakota and Manitoba, supposed to be a permanent breeding ground of the Rocky Mountain locust. This he found not to be the case, and he thinks that the probable breeding ground is on the Assiniboine River, north and east of Regina, a region that will be investigated next season.

ON the occasion of the centenary of the Technical Institute at Charlottenburg, which will take place on October 19th, monuments to Siemens and Krupp will be unveiled.

THE death is announced of M. Gaston Tissandier, well known as æronaut and writer on scientific topics, and founder and editor of the weekly scientific journal *La Nature*. He was 56 years of age.

WE also regret to record the deaths of Professor Theodore Elbert, the German geologist, at the age of 42 years, and of Dr. Max Barth, director of the Agricultural Station of Rufach, in Alsace, at the age of 44 years.

THE new institute, free library and Royal museum just erected at Canterbury was opened on September 11th by the mayor of that city, Alderman George Collard. The bulk of the cost is covered by a bequest of £10,000 left to the city by the late Dr. Beaney, of Melbourne, who was a native of Canterbury. The building was used as the place of reception on the occasion of the visit of the members of the British and French Associations.

IT will be remembered that sometime since, Mr. J. M. Tata, of Bombay, offered a large sum for the establishment of a scientific research institute in India. It appears that some conditions regarding a family settlement were attached, but these have now been withdrawn, and it is hoped that the government may be able to proceed with the establishment of the institute.

THE building for the German Chemical Society of Berlin, to be named Hofmannhaus, in memory of the great German chemist, is now in course of erection, and it is expected that the exterior will be finished before the winter.

MR. ANDREW CARNEGIE has given $50,000 for a free library of Dallas, Texas.

THE Texas Agricultural College and Experiment Station has been provided by the legislature with a new building that will cost $31,000, and also with a dormitory costing $24,000.

THE last session of the legislature of Utah made an appropriation of $6,000 for a State Experiment Station, which will be located in Washington county. It is to be supported entirely by State funds and will not be connected with the station at Logan.

THE *Allegemeine Wissenschaftliche Berichte* learn from Christiana that the Norwegian Störthing will appoint a commission to award the first Nobel prize for the promotion of peace. The award will be made, as we have already stated, on December 10, 1901, the anniversary of Nobel's death, and on the same day the corner-stone will be laid of the Nobel Institute at Christiana. This Institute will have the disposal of 300,000 crowns and a yearly income of 50,000 crowns. It will be devoted especially to the study of international law, and will aim to draw students and lecturers from all nations.

It appears from letters in the London *Times* that a syndicate bought up all the rooms in Dover for the weeks of the meeting of the British Association and sold them to members at extortionate rates.

A CIVIL service examination will be held on October 17th with a view to filling the position of civil and electrical engineer in the engineering department-at-large with a salary of $125 per month.

IN view of the occurrence of cases of the plague in the village of Koloboreka in the Russian Government of Astrakhan, the Prince of Oldenburg has been made President of a commission, consisting of members of the medical council and other experts which will carry out an investigation of the subject. An outbreak of the plague is also reported at Asuncion, Paraguay.

A study of the effect of pressure on the preservation of milk at the Experiment Station of West Virginia University gave such encouraging results that the effect of the same agent in preserving fruits and fruit juices is being studied now while these are in season. It is yet too soon to say whether the work will lead to a practical method for preserving these materials, but it may be said, however, that samples have been prevented from fermenting for five months; also that milk has been kept for three months and meats for seven months.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Edward Tuck, of New York City, has given $300,000 to Dartmouth College to be used for purposes of instruction.

By the will of Mrs. Mary D. Goddard, of Newton, Mass., $60,000 is given to Tufts College.

Princeton University has received from Mr. Stafford Little, of Trenton, N. J., $10,000 to endow a lectureship on themes connected with public life. Ex-president Cleveland will, during the coming year, deliver the first course of lectures.

The medical students of Bowdoin College will receive instruction during their last year at Portland, where suitable buildings are now being erected, and where they will have improved clinical facilities. After 1900 the course will be four years in length, the first two years being spent at Brunswick, and the second two years at Portland.

The following appointments are announced at Dartmouth College: Dr. Gorden F. Hull, of Colorado College, to be assistant professor of physics; Mr. George T. Moore, assistant in Harvard University, to be instructor in botany; and H. H. Horne to be instructor in philosophy.

Samuel Avery, B.Sc. and A.M. (Nebraska). and Ph.D. (Heidelberg), for some years adjunct professor of chemistry in the University of Nebraska, has accepted the professorship of chemistry in the University of Idaho. The position left vacant at Nebraska has been filled by the appointment, as instructor, of Robert Silver Hellner, B.Sc., A.M., assistant chemist in the Nebraska Experiment Station. Mr. Roscoe Wilfred Thatcher, B.Sc. (Nebraska), has been appointed successor to Mr. Hiltner.

Promotions and changes, as follows, were made this year in the force of the Zoological Department at the University of Nebraska, Lincoln: Henry B. Ward, professor; Robert H. Wolcott, adjunct professor; Albert B. Lewis, assistant instructor; Frank E. Watson, fellow and graduate assistant.

Mr. Peter Field, fellow in mathematics in Cornell University, has been appointed professor of mathematics in Carthage College.

Mr. Edwin Haviland, B.S. (Swarthmore, 1895), and A.M. (Cornell, 1899), has been appointed assistant in mathematics in Swarthmore College.

Professor W. H. Squires, who holds the chair of psychology and pedagogics in Hamilton College, has been given a two years' leave of absence, which he will spend in study in Germany. W. B. Elkin, Ph.D. (Cornell), Teachers College, Columbia University, has been appointed acting professor.

At Brown University, Frederic P. Gorham, biology, Ralph W. Tower, chemical physiology, and Arthur E. Watson, physics, have been promoted to assistant professorships.

Frank T. Daniels, assistant professor of civil engineering, at Tufts College, has resigned.

James P. C. Southall, of the University of Virginia, has been appointed instructor in physics at Hobart College; Lindsay Duncan has been made instructor in mathematics, surveying and draughting at Union College. At Smith College, Annie Lyons has been appointed assistant in zoology.

The following appointments as instructors, at Lehigh University, have been made: Robert M. Wilson, E.E. (Cornell), Barry MacNutt M.S. (Lehigh), and J. S. Viehe, E.E. (Lehigh), to be instructors in electrical engineering; Herman Schneider, B.S. (Lehigh), to be instructor in civil engineering, and Amasa Trowbridge, Ph.B. (Sheffield Scientific School), and chief engineer, U. S. S., *Catskill*, during the late war, to be instructor in mechanical engineering.

SCIENCE

FRIDAY, OCTOBER 6, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ADDRESS BY THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

HE who until a few minutes ago was your president said somewhere at the meeting at Bristol, and said with truth, that among the qualifications needed for the high honor of Presidency of the British Association for the Advancement of Science, that of being old was becoming more and more dominant. He who is now attempting to speak to you feels that he is rapidly earning that distinction. But the Association itself is older than its President; it has seen pass away the men who, wise in their generation, met at York on September 27, 1831, to found it; it has seen other great men who in bygone years served it as presidents, or otherwise helped it on, sink one after another into the grave. Each year, indeed, when it plants its flag as a signal of its yearly meeting, that flag floats half-mast high in token of the great losses which the passing year has brought. This year is no exception; the losses, indeed, are perhaps unwontedly heavy. I will not attempt to call over the sad roll-call; but I must say a word about one who was above most others a faithful and zealous friend of the Association. Sir Douglas Galton joined the Association in 1860. From 1871 to 1895, as one of the General Secretaries, he bore, and bore to the great good of the Associa-

* Dover Meeting, 1899.

tion, a large share of the burden of the Association's work. How great that share was is perhaps especially known to the many men, among whom I am proud to count myself, who during his long term of office served in succession with him as brother General Secretary. In 1895, at Ipswich, he left the post of General Secretary, but only to become President. So long and so constantly did he labor for the good of the Association that he seemed to be an integral part of it, and meeting as we do to-day, and as we henceforward must do, without Douglas Galton, we feel something greatly missing. This year, perhaps even more than in other years, we could have wished him to be among us; for to-day the Association may look with joy, not unmixed with pride, on the realization of a project in forwarding which it has had a conspicuous share, on the commencement of an undertaking which is not only a great thing in itself, but which, we trust, is the beginning of still greater things to come. And the share which the Association has had in this was largely Sir Douglas Galton's doing. In his address as President of Section A, at the meeting of the Association at Cardiff in 1891, Professor Oliver Lodge expounded with pregnant words how urgently, not pure science only, but industry and the constructive arts—for the interests of these are ever at bottom the same—needed the aid of some national establishment for the prosecution of prolonged and costly physical researches, which private enterprise could carry out in a lame fashion only, if at all. Lodge's words found an echo in many men's minds; but the response was for a long while in men's minds only. In 1895, Sir Douglas Galton, having previously made a personal study of an institution analogous to the one desired—namely, the Reichsanstalt at Berlin—seized the opportunity offered to him as President of the Association at Ipswich to insist, with the authority not only of the head for the time being of a great scientific body, but also of one who himself knew the ways and wants at once of science and of practical life, that the thing which Lodge and others had hoped for was a thing which could be done, and ought to be done at once. And now to-day we can say it has been done. The National Physical Laboratory has been founded. The address at Ipswich marked the beginning of an organized effort which has at last been crowned with success. A feeling of sadness cannot but come over us when we think that Sir Douglas Galton was not spared to see the formal completion of the scheme whose birth he did so much to help, and which, to his last days, he aided in more ways than one. It is the old story—the good which men do lives after them.

Still older than the Association is this nineteenth century, now swiftly drawing to its close. Though the century itself has yet some sixteen months to run, this is the last meeting of the British Association which will use the numbers eighteen hundred to mark its date.

The eyes of the young look ever forward; they take little heed of the short though ever-lengthening fragment of life which lies behind them; they are wholly bent on that which is to come. The eyes of the aged turn wistfully again and again to the past; as the old glide down the inevitable slope their present becomes a living over again the life which has gone before, and the future takes on the shape of a brief lengthening of the past. May I this evening venture to give rein to the impulses of advancing years? May I, at this last meeting of the Association in the eighteen hundreds, dare to dwell for a while upon the past, and to call to mind a few of the changes which have taken place in the world since those autumn days in which men were saying to each other that the last

of the seventeen hundreds was drawing towards its end?

Dover in the year of our Lord seventeen hundred and ninety-nine was in many ways unlike the Dover of to-day. On moonless nights men groped their way in its narrow streets by the help of swinging lanterns and smoky torches, for no lamps lit the ways. By day the light of the sun struggled into the houses through narrow panes of blurred glass. Though the town then, as now, was one of the chief portals to and from the countries beyond the seas, the means of travel were scanty and dear, available for the most part to the rich alone, and, for all, beset with discomfort and risk. Slow and uncertain was the carriage of goods, and the news of the world outside came to the town—though it from its position learnt more than most towns—tardily, fitfully, and often falsely. The people of Dover sat then much in dimness, if not in darkness, and lived in large measure on themselves. They who study the phenomena of living beings tell us that light is the great stimulus of life, and that the fullness of the life of a being or of any of its members may be measured by the variety, the swiftness, and the certainty of the means by which it is in touch with its surroundings. Judged from this standpoint life at Dover then, as indeed elsewhere, must have fallen far short of the life of to-day.

The same study of living beings, however, teaches us that while from one point of view the environment seems to mould the organism, from another point the organism seems to be master of its environment. Going behind the change of circumstances, we may raise the question, the old question, Was life in its essence worth more then than now? Has there been a real advance?

Let me at once relieve your minds by saying that I propose to leave this question in the main unanswered. It may be, or it may not be, that man's grasp of the beautiful and of the good, if not looser, is not firmer than it was a hundred years ago. It may be, or it may not be, that man is no nearer to absolute truth, to seeing things as they really are, than he was then. I will merely ask you to consider with me for a few minutes how far, and in what ways, man's laying hold of that aspect of or part of truth which we call natural knowledge, or sometimes science, differed in 1799 from what it is to-day, and whether that change must not be accounted a real advance, a real improvement in man.

I do not propose to weary you by what in my hands would be the rash effort of attempting a survey of all the scientific results of the nineteenth century. It will be enough if for a little while I dwell on some few of the salient features distinguishing the way in which we nowadays look upon, and during the coming week shall speak of, the works of Nature around us—though those works themselves, save for the slight shifting involved in a secular change, remain exatcly the same—from the way in which they were looked upon and might have been spoken of at a gathering of philosophers at Dover in 1799. And I ask your leave to do so.

In the philosophy of the ancients, earth, fire, air, and water were called 'the elements.' It was thought, and rightly thought, that a knowledge of them and of their attributes was a necessary basis of a knowledge of the ways of Nature. Translated into modern language, a knowledge of these 'elements' of old means a knowledge of the composition of the atmosphere, of water, and of all the other things which we call matter, as well as a knowledge of the general properties of gases, liquids, and solids, and of the nature and effects of combustion. Of all these things our knowledge to-day is large and exact, and, though ever enlarging, in some respects complete. When did that knowledge begin to become exact?

To-day the children in our schools know that the air which wraps round the globe is is not a single thing, but is made up of two things, oxygen and nitrogen,* mingled together. They know, again, that water is not a single thing, but the product of two things, oxygen and hydrogen, joined together. They know that when the air makes the fire burn and gives the animal life, it is the oxygen in it which does the work. They know that all round them things are undergoing that union with oxygen which we call oxidation, and that oxidation is the ordinary source of heat and light. Let me ask you to picture to yourselves what confusion there would be to-morrow, not only in the discussions at the sectional meetings of our Association, but in the world at large, if it should happen that in the coming night some destroying touch should wither up certain tender structures in all our brains, and wipe out from our memories all traces of the ideas which cluster in our minds around the verbal tokens, oxygen and oxidation. How could any of us, not the so-called man of science alone, but even the man of business and the man of pleasure, go about his ways lacking those ideas? Yet those ideas were in 1799 lacking to all but a few.

Although in the third quarter of the seventeenth century the light of truth about oxidation and combustion had flashed out in the writings of John Mayow, it came as a flash only, and died away as soon as it had come. For the rest of that century, and for the greater part of the next, philosophers stumbled about in darkness, misled for the most of the time by the phantom conception which they called phlogiston. It was not until the end of the third quarter of the eighteenth century that the new light, which has burned steadily ever since, lit up the minds of the men of science. The light came at nearly the same time from England and from France. Rounding off the sharp corners of controversy, and joining, as we may fitly do to-day, the two countries as twin bearers of a common crown, we may say that we owe the truth to Cavendish, to Lavoisier, and Priestley. If it was Priestley who was the first to demonstrate the existence of what we now call oxygen, it is to Lavoisier we owe the true conception of the nature of oxidation and the clear exposition of the full meaning of Priestley's discovery, while the knowledge of the composition of water, the necessary complement of the knowledge of oxygen, came to us through Cavendish and, we may perhaps add, through Watt.

The date of Priestley's discovery of oxygen is 1774, Lavoisier's classic memoir 'on the nature of the principle which enters into combination with metals during calcination' appeared in 1775, and Cavendish's paper on the composition of water did not see the light until 1784.

During the last quarter of the eighteenth century this new idea of oxygen and oxidation was struggling into existence. How new was the idea is illustrated by the fact that Lavoisier himself at first spoke of that which he was afterwards, namely, in 1778, led to call oxygen, the name by which it has since been known, as 'the principle which enters into combination.' What difficulties its acceptance met with is illustrated by the fact that Priestley himself refused to the end of his life to grasp the true bearings of the discovery which he had made. In the year 1799 the knowledge of oxygen, of the nature of water and of air, and indeed the true conception of chemical composition and chemical change, was hardly more than beginning to be, and the century had to pass wholly away before the next great chemical idea, which we know by the name of the Atomic Theory of John Dalton, was made known. We have only to

*Some may already know that there is at least a third thing, argon.

read the scientific literature of the time to recognize that a truth which is now not only woven as a master-thread into all our scientific conceptions, but even enters largely into the everyday talk and thoughts of educated people, was a hundred years ago struggling into existence among the philosophers themselves. It was all but absolutely unknown to the large world outside those select few.

If there be one word of science which is writ large on the life of the present time, it is the word 'electricity'; it is, I take it, writ larger than any other word. The knowledge which it denotes has carried its practical results far and wide into our daily life, while the theoretical conceptions which it signifies pierce deep into the nature of things. We are to-day proud, and justly proud, both of the material triumphs and of the intellectual gains which it has brought us, and we are full of even larger hopes of it in the future.

At what time did this bright child of the nineteenth century have its birth?

He who listened to the small group of philosophers of Dover, who in 1799 might have discoursed of natural knowledge would perhaps have heard much of electric machines, of electric sparks, of the electric fluid, and even of positive and negative electricity; for frictional electricity had long been known and even carefully studied. Probably one or more of the group, dwelling on the observations which Galvani, an Italian, had made known some twenty years before, developed views on the connection of electricity with the phenomena of living bodies. Possibly one of them was exciting the rest by telling how he had just heard that a professor at Pavia, one Volta, had discovered that electricity could be produced not only by rubbing together particular bodies, but by the simple contact of two metals, and had thereby explained Galvani's remarkable results. For, indeed, as we shall hear from Professor Fleming, it was in that very year, 1799, that electricity as we now know it took its birth. It was then that Volta brought to light the apparently simple truths out of which so much has sprung. The world, it is true, had to wait for yet some twenty years before both the practical and the theoretic worth of Volta's discovery became truly pregnant, under the fertilizing influence of another discovery. The loadstone and magnetic virtues had, like the electrifying power of rubbed amber, long been an old story. But, save for the compass, not much had come from it. And even Volta's discovery might have long remained relatively barren had it been left to itself. When, however, in 1819, Oersted made known his remarkable observations on the relations of electricity to magnetism, he made the contact needed for the flow of a new current of ideas. And it is perhaps not too much to say that those ideas, developing during the years of the rest of the century with an ever-accelerating swiftness, have wholly changed man's material relations to the circumstances of life, and at the same time carried him far in his knowledge of the nature of things.

Of all the various branches of science, none perhaps is to-day, none for these many years past has been, so well known to, even if not understood by, most people as that of geology. Its practical lessons have brought wealth to many; its fairy tales have brought delight to more; and round it hovers the charm of danger, for the conclusions to which it needs touch on the nature of man's beginning.

In 1799, the science of geology, as we now know it, was struggling into birth. There had been from of old cosmogonies, theories as to how the world had taken shape out of primæval chaos. In that fresh spirit which marked the zealous search after natural knowledge pursued in the middle

and latter part of the seventeenth century, the brilliant Stenson, in Italy, and Hooke, in our own country, had laid hold of some of the problems presented by fossil remains, and Woodward, with others, had labored in the same field. In the eighteenth century, especially in its latter half, men's minds were busy about the physical agencies determining or modifying the features of the earth's crust; water and fire, subsidence from a primæval ocean and transformation by outbursts of the central heat, Neptune and Pluto, were being appealed to, by Werner on the one hand, and by Desmarest on the other, in explanation of the earth's phenomena. The way was being prepared, theories and views were abundant, and many sound observations had been made; and yet the science of geology, properly so called, the exact and proved knowledge of the successive phases of the world's life, may be said to date from the closing years of the eighteenth century.

In 1783, James Hutton put forward in a brief memoir his 'Theory of the Earth,' which in 1795, two years before his death, he expanded into a book; but his ideas failed to lay hold of men's minds until the century had passed away, when in 1802, they found an able expositor in John Playfair. The very same year that Hutton published his theory, Cuvier came to Paris and almost forth with began, with Brongniart, his immortal researches into the fossils of Paris and its neighborhood. And four years later, in the year 1799 itself, William Smith's tabular list of strata and fossils saw the light. It is, I believe, not too much to say that out of these geology, as we now know it, sprang. It was thus in the closing years of the eighteenth century that was begun the work which the nineteenth century has carried forward to such great results. But at this time only the select few had grasped the truth, and even they only the beginning of it. Outside a narrow circle the thoughts, even of the educated, about the history of the globe were bounded by the story of the Deluge—though the story was often told in a strange fashion—or were guided by fantastic views of the plastic forces of a sportive Nature.

In another branch of science, in that which deals with the problems presented by living beings, the thoughts of men in 1799 were also very different from the thoughts of men to-day. It is a very old quest, the quest after the knowledge of the nature of living beings, one of the earliest on which man set out; for it promised to lead him to a knowledge of himself, a promise which perhaps is still before us, but the fulfillment of which is yet far off. As time has gone on, the pursuit of natural knowledge has seemed to lead man away from himself into the furthermost parts of the universe, and into secret workings of Nature in which he appears to be of little or no account; and his knowledge of the nature of living things, and so of his own nature, has advanced slowly, waiting till the progress of other branches of natural knowledge can bring it aid. Yet in the past hundred years, the biologic sciences, as we now call them, have marched rapidly onward.

We may look upon a living body as a machine doing work in accordance with certain laws, and may seek to trace out the working of the inner wheels, how these raise up the lifeless dust into living matter, and let the living matter fall away again into dust, giving out movement and heat. Or we may look upon the individual life as a link in a long chain, joining something which went before to something about to come, a chain whose beginning lies hid in the farthest past, and may seek to know the ties which bind one life to another. As we call up to view the long series of living forms, living now or flitting like shadows on the screen of the past, we may strive to

lay hold of the influences which fashion the garment of life. Whether the problems of life are looked upon from the one point of view or the other, we to-day, not biologists only, but all of us, have gained a knowledge hidden even from the philosophers a hundred years ago.

Of the problems presented by the living body viewed as a machine, some may be spoken of as mechanical, others as physical, and yet others as chemical, while some are, apparently at least, none of these. In the seventeenth century William Harvey, laying hold of the central mechanism of the blood stream, opened up a path of inquiry which his own age and the century which followed trod with marked success. The knowledge of the mechanics of the animal and of the plant advanced apace, but the physical and chemical problems had yet to wait. The eighteenth century, it is true, had its physics and its chemistry; but in relation at least to the problems of the living being, a chemistry which knew not oxygen and a physics which knew not the electricity of chemical action were of little avail. The philosopher of 1799, when he discussed the functions of the animal or of the plant involving chemical changes, was fain for the most part, as were his predecessors in the century before, to have recourse to such vague terms as 'fermentation' and the like; to-day our treatises on physiology are largely made up of precise and exact expositions of the play of physical agencies and chemical bodies in the living organisms. He made use of the words 'vital force' or 'vital principle' not as an occasional, but as a common, explanation of the phenomena of the living body. During the present century, especially during its latter half, the idea embodied in those words has been driven away from one seat after another; if we use it now when we are dealing with the chemical and physical events of life, we use it with reluctance, as a *deus ex machina* to be appealed to only when everything else has failed.

Some of the problems—and those, perhaps, the chief problems—of the living body have to be solved neither by physical nor chemical methods, but by methods of their own. Such are the problems of the nervous system. In respect to these the men of 1799 were on the threshold of a pregnant discovery. During the latter part of the present century, and especially during its last quarter, the analysis of the mysterious processes in the nervous system, and especially in the brain, which issue as feeling, thought and the power to move, has been pushed forward with a success conspicuous in its practical, and full of promise in its theoretical, gains. That analysis may be briefly described as a following up of threads. We now know that what takes place along a tiny thread which we call a nerve-fiber differs from that which takes place along its fellow-threads, that differing nervous impulses travel along different nervous-fibers, and that nervous and psychical events are the outcome of the clashing of nervous impulses as they sweep along the closely-woven web of living threads of which the brain is made. We have learnt by experiment and by observation that the pattern of the web determines the play of the impulses, and we can already explain many of the obscure problems not only of nervous disease, but of nervous life, by an analysis which is a tracking out the devious and linked paths of nervous threads. The very beginning of this analysis was unknown in 1799. Men knew that nerves were the agents of feeling and of the movements of muscles; they had learnt much about what this part or or that part of the brain could do; but they did not know that one nerve-fiber differed from another in the very essence of its work. It was just about the end of the past century, or the beginning of the pres-

ent one, that an English surgeon began to ponder over a conception which, however, he did not make known until some years later, and which did not gain complete demonstration and full acceptance until still more years had passed away. It was in 1811, in a tiny pamphlet published privately, that Charles Bell put forth his 'New Idea' that the nervous system was constructed on the principle that "the nerves are not single nerves possessing various powers, but bundles of different nerves, whose filaments are united for the convenience of distribution, but which are distinct in office as they are in origin from the brain."

Our present knowledge of the nervous system is to a large extent only an exemplification and expansion of Charles Bell's 'New Idea,' and has its origin in that.

If we pass from the problems of the living organism viewed as a machine, to those presented by the varied features of the different creatures who have lived or who still live on the earth, we at once call to mind that the middle years of the present century mark an epoch in biologic thought such as never came before, for it was then that Charles Darwin gave to the world the 'Origin of Species.'

That work, however, with all the far-reaching effects which it has had, could have had little or no effect, or, rather, could not have come into existence, had not the earlier half of the century been in travail preparing for its coming. For the germinal idea of Darwin appeals, as to witnesses, to the results of two lines of biologic investigation which were almost unknown to the men of the eighteenth century.

To one of these lines I have already referred. Darwin, as we know, appealed to the geological record; and we also know how that record, imperfect as it was then, and imperfect as it must always remain, has since his time yielded the most striking proofs of at least one part of his general conception. In 1799 there was, as we have seen, no geological record at all.

Of the other line I must say a few words.

To-day the merest beginner in biologic study, or even that exemplar of acquaintance without knowledge, the general reader, is aware that every living being, even man himself, begins its independent existence as a tiny ball, of which we can, even acknowledging to the full the limits of the optical analysis at our command, assert with confidence that in structure, using that word in its ordinary sense, it is in all cases absolutely simple. It is equally well known that the features of form which supply the characters of a grown-up living being, all the many and varied features of even the most complex organism, are reached as the goal of a road, at times a long road, of successive changes; that the life of every being, from the ovum to its full estate, is a series of shifting scenes, which come and go, sometimes changing abruptly, sometimes melting the one into the other, like dissolving views, all so ordained that often the final shape with which the creature seems to begin, or is said to begin its life in the world is the outcome of many shapes, clothed with which it in turn has lived many lives before its seeming birth.

All or nearly all the exact knowledge of the labored way in which each living creature puts on its proper shape and structure is the heritage of the present century. Although the way in which the chick is moulded in the egg was not wholly unknown even to the ancients, and in later years had been told, first in the sixteenth century by Fabricius, then in the seventeenth century in a more clear and striking manner by the great Italian naturalist, Malpighi, the teaching thus offered had been neglected or misinterpreted. At the close of the eighteenth century the dominant view was that in the making of a crea-

ture out of the egg there was no putting on of wholly new parts, no epigenesis. It was taught that the entire creature lay hidden in the egg, hidden by reason of the very transparency of its substance, lay ready-made but folded up, as it were, and that the process of development within the egg or within the womb was a mere unfolding, a simple evolution. Nor did men shrink from accepting the logical outcome of such a view—namely, that within the unborn creature itself lay in like manner, hidden and folded up, its offspring also, and within that again its offspring in turn, after the fashion of a cluster of ivory balls carved by Chinese hands, one within the other. This was no fantastic view put forward by an imaginative dreamer; it was seriously held by sober men, even by men like the illustrious Haller, in spite of their recognizing that as the chick grew in the egg some changes of form took place. Though so early as the middle of the eighteenth century Friedrich Casper Wolff and, later on, others had strenuously opposed such a view, it held its own not only to the close of the century, but far on into the next. It was not until a quarter of the present century had been added to the past that Von Baer made known the results of researches which once and for all swept away the old view. He and others working after him made it clear that each individual puts on its final form and structure not by an unfolding of preëxisting hidden features, but by the formation of new parts through the continued differentiation of a primitively simple material. It was also made clear that the successive changes which the embryo undergoes in its progress from the ovum to maturity are the expression of morphologic laws, that the progress is one from the general to the special, and that the shifting scenes of embryonic life are hints and tokens of lives lived by ancestors in times long past.

If we wish to measure how far off in biologic thought the end of the last century stands, not only from the end, but even from the middle of this one, we may imagine Darwin striving to write the 'Origin of Species' in 1799. We may fancy him being told by philosophers explaining how one group of living beings differed from another group because all its members and all their ancestors came into existence at one stroke when the first-born progenitor of the race, within which all the rest were folded up, stood forth as the result of a creative act. We may fancy him listening to a debate between the philosopher who maintained that all the fossils strewn in the earth were the remains of animals or plants churned up in the turmoil of a violent universal flood, and dropped in their places as the waters went away, and him who argued that such were not really the 'spoils of living creatures,' but the products of some playful plastic power which out of the superabundance of its energy fashioned here and there the lifeless earth into forms which imitated, but only imitated, those of living things. Could he amid such surroundings by any flight of genius have beat his way to the conception for which his name will ever be known?

Here I may well turn away from the past. It is not my purpose, nor, as I have said, am I fitted, nor is this perhaps the place, to tell even in outline the tale of the work of science in the nineteenth century. I am content to have pointed out that the two great sciences of chemistry and geology took their birth, or at least began to stand alone, at the close of the last century, and have grown to be what we know them now within about a hundred years, and that the study of living beings has within the same time been so transformed as to be to-day something wholly different from what it was in 1799. And, indeed, to say more would

be to repeat almost the same story about other things. If our present knowledge of electricity is essentially the child of the nineteenth century, so also is our present knowledge of many other branches of physics. And those most ancient forms of exact knowledge, the knowledge of numbers and of the heavens, whose beginning is lost in the remote past, have, with all other kinds of natural knowledge, moved onward during the whole of the hundred years with a speed which is ever increasing. I have said, I trust, enough to justify the statement that in respect to natural knowledge a great gulf lies between 1799 and 1899. That gulf, moreover, is a two-fold one: not only has natural knowledge been increased, but men have run to and fro spreading it as they go. Not only have the few driven far back round the full circle of natural knowledge the dark clouds of the unknown which wrap us all about, but also the many walk in the zone of light thus increasingly gained. If it be true that the few to-day are, in respect to natural knowledge, far removed from the few of those days, it is also true that nearly all which the few alone knew then, and much which they did not know, has now become the common knowledge of the many.

What, however, I may venture to insist upon here is that the difference in respect to natural knowledge, whatever be the case with other differences between then and now, is undoubtedly a difference which means progress. The span between the science of that time and the science of to-day is beyond all question a great stride onwards.

We may say this, but we must say it without boasting. For the very story of the past which tells of the triumphs of science bids the man of science put away from him all thoughts of vainglory—and that by many tokens.

Whoever, working at any scientific problem, has occasion to study the inquiries into the same problem made by some fellow-worker in the years long gone by, comes away from that study humbled by one or other of two different thoughts. On the one hand he may find, when he has translated the language of the past into the phraseology of to-day, how near was his forerunner of old to the conception which he thought, with pride, was all his own, not only so true but so new. On the other hand, if the ideas of the investigator of old, viewed in the light of modern knowledge, are found to be so wide of the mark as to seem absurd, the smile which begins to play upon the lips of the modern is checked by the thought, Will the ideas which I am now putting forth, and which I think explain so clearly, so fully, the problem in hand, seem to some worker in the far future as wrong and as fantastic as do these of my forerunner to me? In either case his personal pride is checked. Further, there is written clearly on each page of the history of science, in characters which cannot be overlooked, the lesson that no scientific truth is born anew, coming by itself and of itself. Each new truth is always the offspring of something which has gone before, becoming in turn the parent of something coming after. In this aspect the man of science is unlike, or seems to be unlike, the poet and the artist. The poet is born, not made; he rises up, no man knowing his beginnings; when he goes away, though men after him may sing his songs for centuries, he himself goes away wholly, having taken with him his mantle, for this he can give to none other. The man of science is not thus creative; he is created. His work, however great it be, is not wholly his own; it is in part the outcome of the work of men who have gone before. Again and again a conception which has made a name great has come not so much by the man's own effort as out of the fullness of time. Again

and again we may read in the words of some man of old the outlines of an idea which in later days has shone forth as a great acknowledged truth. From the mouth of the man of old the idea dropped barren, fruitless; the world was not ready for it, and heeded it not; the concomitant and abutting truths which could give it power to work were wanting. Coming back again in later days, the same idea found the world awaiting it; things were in travail preparing for it: and someone, seizing the right moment to put it forth again, leapt into fame. It is not so much the men of science who make science, as some spirit which, born of the truths already won, drives the man of science onward and uses him to win new truths in turn.

It is because each man of science is not his own master, but one of many obedient servants of an impulse which was at work long before him, and will work long after him, that in science there is no falling back. In respect to other things there may be times of darkness and times of light, there may be risings, decadences and revivals. In science there is only progress. The path may not be always a straight line, there may be swerving to this side and to that, ideas may seem to return again and again to the same point of the intellectual compass; but it will always be found that they have reached a higher level—they have moved, not in a circle, but in a spiral. Moreover, science is not fashioned as is a house, by putting brick to brick, that which is once put remaining as it was put to the end. The growth of science is that of a living being. As in the embryo phase follows phase, and each member or body puts on in succession different appearances, though all the while the same member, so a scientific conception of one age seems to differ from that of a following age, though it is the same one in the process of being made; and as the dim outlines of the early embryo become, as the being grows more distinct and sharp, like a picture on a screen brought more and more into focus, so the dim gropings and searchings of the men of science of old are by repeated approximations wrought into the clear and exact conclusions of later times.

The story of natural knowledge, of science, in the nineteenth century, as, indeed, in preceding centuries, is, I repeat, a story of continued progress. There is in it not so much as a hint of falling back, not even of standing still. What is gained by scientific inquiry is gained forever; it may be added to, it may seem to be covered up, but it can never be taken away. Confident that the progress will go on, we cannot help peering into the years to come and straining our eyes to foresee what science will become and what it will do as they roll on. While we do so, the thought must come to us, Will all the increasing knowledge of Nature avail only to change the ways of man—will it have no effect on man himself?

The material good which mankind has gained and is gaining through the advance of science is so imposing as to be obvious to everyone, and the praises of this aspect of science are to be found in the mouths of all. Beyond all doubt science has greatly lessened and has markedly narrowed hardship and suffering; beyond all doubt science has largely increased and has widely diffused ease and comfort. The appliances of science have, as it were, covered with a soft cushion the rough places of life, and that not for the rich only, but also for the poor. So abundant and so prominent are the material benefits of science that in the eyes of many these seem to be the only benefits which she brings. She is often spoken of as if she were useful and nothing more, as if her work were only to administer to the material wants of man.

Is this so?

We may begin to doubt it when we reflect that the triumphs of science which bring these material advantages are in their very nature intellectual triumphs. The increasing benefits brought by science are the results of man's increasing mastery over Nature, and that mastery is increasingly a mastery of mind; it is an increasing power to use the forces of what we call inanimate nature in place of the force of his own or other creatures' bodies; it is an increasing use of mind in place of muscle.

Is it to be thought that that which has brought the mind so greatly into play has had no effect on the mind itself? Is that part of the mind which works out scientific truths a mere slavish machine producing results it knows not how, having no part in the good which in its working it brings forth?

What are the qualities, the features of that scientific mind which has wrought, and is working, such great changes in man's relation to Nature? In seeking an answer to this question we have not to inquire into the attributes of genius. Though much of the progress of science seems to take on the form of a series of great steps, each made by some great man, the distinction in science between the great discoverer and the humble worker is one of degree only, not of kind. As I was urging just now, the greatness of many great names in science is often, in large part, the greatness of occasion, not of absolute power. The qualities which guide one man to a small truth silently taking its place among its fellows, as these go to make up progress, are at bottom the same as those by which another man is led to something of which the whole world rings.

The features of the fruitful scientific mind are in the main three.

In the first place, above all other things, his nature must be one which vibrates in unison with that of which he is in search; the seeker after truth must himself be truthful, truthful with the truthfulness of Nature. For the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting. Man, unscientific man, is often content with 'the nearly' and 'the almost.' Nature never is. It is not her way to call the same two things which differ, though the difference may be measured by less than a thousandth of a milligram or of a millimeter, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signet to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and the more strenuously he struggles on, the farther will he find himself from his true goal.

In the second place, he must be alert of mind. Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper however low.

In the third place, scientific inquiry, though it be preëminently an intellectual effort, has need of the moral quality of courage—not so much the courage which helps a man to face a sudden difficulty as the courage of steadfast endurance. Almost every inquiry, certainly every prolonged inquiry, sooner or later goes wrong. The path, at first so straight and clear, grows crooked and gets blocked; the hope and enthusiasm, or even the jaunty ease, with which the inquirer set out, leave him

and he falls into a slough of despond. That is the critical moment calling for courage. Struggling through the slough he will find on the other side of the wicket-gate opening up the real path; losing heart he will turn back and add one more stone to the great cairn of the unaccomplished.

But, I hear someone say, these qualities are not the peculiar attributes of the man of science, they may be recognized as belonging to almost everyone who has commanded or deserved success, whatever may have been his walk of life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organized common sense, and men of science are common men, drilled in the ways of common sense.

For their life has this feature. Though in themselves they are no stronger, no better than other men, they possess a strength which, as I just now urged, is not their own but is that of the science whose servants they are. Even in his apprenticeship, the scientific inquirer, while learning what has been done before his time, if he learns it aright, so learns it that what is known may serve him not only as a vantage ground whence to push off into the unknown, but also as a compass to guide him in his course. And when fitted for his work he enters on inquiry itself, what a zealous anxious guide, what a strict and, because strict, helpful school-mistress does Nature make herself to him! Under her care every inquiry, whether it bring the inquirer to a happy issue or seem to end in nought, trains him for the next effort. She so orders her ways that each act of obedience to her makes the next act easier for him, and step by step she leads him on towards that perfect obedience which is complete mastery.

Indeed, when we reflect on the potency of the discipline of scientific inquiry we cease to wonder at the progress of scientific knowledge. The results actually gained seem to fall so far short of what under such guidance might have been expected to have been gathered in that we are fain to conclude that science has called to follow her, for the most part, the poor in intellect and the wayward in spirit. Had she called to her service the many acute minds who have wasted their strength struggling in vain to solve hopeless problems, or who have turned their energies to things other than the increase of knowledge; had she called to her service the many just men who have walked straight without the need of a rod to guide them, how much greater than it has been would have been the progress of science, and how many false teachings would the world have been spared! To men of science themselves, when they consider their favored lot, the achievements of the past should serve not as a boast but as a reproach.

If there be any truth in what I have been urging, that the pursuit of scientific inquiry is itself a training of special potency, giving strength to the feeble and keeping in the path those who are inclined to stray, it is obvious that the material gains of science, great as they may be, do not make up all the good which science brings or may bring to man. We especially, perhaps, in these later days, through the rapid development of the physical sciences, are too apt to dwell on the material gains alone. As a child in its infancy looks upon its mother only as a giver of good things, and does not learn till in after days how she was also showing her love by carefully training it in the way it should go, so we, too, have thought too much of the gifts of science, overlooking her power to guide.

Man does not live by bread alone, and science brings him more than bread. It is

a great thing to make two blades of grass grow where before one alone grew; but it is no less great a thing to help a man to come to a just conclusion on the questions with which he has to deal. We may claim for science that while she is doing the one she may be so used as to do the other also. The dictum just quoted, that science is organized common sense, may be read as meaning that the common problems of life which common people have to solve are to be solved by the same methods by which the man of science solves his special problems. It follows that the training which does so much for him may be looked to as promising to do much for them. Such aid can come from science on two conditions only. In the first place, this her influence must be acknowledged; she must be duly recognized as a teacher no less than as a hewer of wood and a drawer of water. And the pursuit of science must be followed not by the professional few only, but, at least in such measure as will ensure the influence of example, by the many. But this latter point I need not urge before this great Association, whose chief object during more than half a century has been to bring within the fold of science all who would answer to the call. In the second place, it must be understood that the training to be looked for from science is the outcome not of the accumulation of scientific knowledge, but of the practice of scientific inquiry. Man may have at his fingers' ends all the accomplished results and all the current opinions of any one or of all the branches of science, and yet remain wholly unscientific in mind; but no one can have carried out even the humblest research without the spirit of science in some measure resting upon him. And that spirit may in part be caught even without entering upon an actual investigation in search of a new truth. The learner may be led to old truths, even the oldest, in more ways than one. He may be brought abruptly to a truth in its finished form, coming straight to it like a thief climbing over the wall; and the hurry and press of modern life tempt many to adopt this quicker way. Or he may be more slowly guided along the path by which the truth was reached by him who first laid hold of it. It is by this latter way of learning the truth, and by this alone, that the learner may hope to catch something at least of the spirit of the scientific inquirer.

This is not the place, nor have I the wish, to plunge into the turmoil of controversy; but, if there be any truth in what I have been urging, then they are wrong who think that in the schooling of the young, science can be used with profit only to train those for whom science will be the means of earning their bread. It may be that from the point of view of pedagogic art the experience of generations has fashioned out of the older studies of literature an instrument of discipline of unusual power, and that the teaching of science is as yet but a rough tool in unpracticed hands. That, however, is not an adequate reason why scope should not be given for science to show the value which we claim for it as an intellectual training fitted for all sorts and conditions of men. Nor need the studies of humanity and literature fear her presence in the schools, for if her friends maintain that the teaching is one-sided, and therefore misleading, which deals with the doings of man only, and is silent about the works of Nature, in the sight of which he and his doings shrink almost to nothing, she herself would be the first to admit that that teaching is equally wrong which deals only with the works of Nature and says nothing about the doings of man, who is, to us at least, Nature's center.

There is yet another general aspect of science on which I would crave leave to say

a word. In that broad field of human life which we call politics, in the struggle not of man with man, but of race with race, science works for good. If we look only on the surface it may at first sight seem otherwise. In no branch of science has there during these later years been greater activity and more rapid progress than in that which furnishes the means by which man brings death, suffering and disaster on his fellow-men. If the healer can look with pride on the increased power which science has given him to alleviate human suffering and ward off the miseries of disease, the destroyer can look with still greater pride on the power which science has given him to sweep away lives and to work desolation and ruin: while the one has slowly been learning to save units, the other has quickly learnt to slay thousands. But, happily. the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long?—wholly to put an end to it; in the words of Tacitus, though in another sense, the very preparations for war, through the character which science gives them, make for peace.

Moreover, not in one branch of science only, but in all, there is a deep undercurrent of influence sapping the very foundations of all war. As I have already urged, no feature of scientific inquiry is more marked than the dependence of each step forward on other steps which have been made before. The man of science cannot sit by himself in his own cave weaving out results by his own efforts, unaided by others, heedless of what others have done and are doing. He is but a bit of a great system, a joint in a great machine, and he can only work aright when he is in due touch with his fellow-workers. If his labor is to be what it ought to be, and is to have the weight which it ought to have, he must know what is being done, not by himself, but by others, and by others not of his own land and speaking his tongue only, but also of other lands and of other speech. Hence it comes about that to the man of science the barriers of manners and of speech which pen men into nations become more and more unreal and indistinct. He recognizes his fellow-worker, wherever he may live, and whatever tongue he may speak, as one who is pushing forward shoulder to shoulder with him towards a common goal, as one whom he is helping and who is helping him. The touch of science makes the whole world kin.

The history of the past gives us many examples of this brotherhood of science. In the revival of learning throughout the sixteenth and seventeenth centuries, and some way on into the eighteenth century, the common use of the Latin tongue made intercourse easy. In some respects in those earlier days science was more cosmopolitan than it afterwards became. In spite of the difficulties and hardships of travel, the men of science of different lands again and again met each other face to face, heard with their ears, and saw with their eyes what their brethren had to say or show. The Englishman took the long journey to Italy to study there; the Italian, the Frenchman and the German wandered from one seat of learning to another; and many a man held a chair in a country not his own. There was help, too, as well as intercourse. The Royal Society of London took upon itself the task of publishing nearly all the works of the great Italian Malpighi, and the brilliant Lavoisier, two years before his own countrymen in their blind fury slew him, received from the same body the highest token which it could give of its esteem.

In these closing years of the nineteenth century this great need of mutual knowledge and of common action felt by men of science of different lands is being mani-

fested in a special way. Though nowadays what is done anywhere is soon known everywhere, the news of a discovery being often flashed over the globe by telegraph, there is an increasing activity in the direction of organization to promote international meetings and international coöperation. In almost every science inquirers from many lands now gather together at stated intervals in international congresses to discuss matters which they have in common at heart, and go away each one feeling strengthened by having met his brother. The desire that in the struggle to lay bare the secrets of Nature the least waste of human energy should be incurred is leading more and more to the concerted action of nations combining to attack problems the solution of which is difficult and costly. The determination of standards of measurement, magnetic surveys, the solution of great geodetic problems, the mapping of the heavens and of the earth—all these are being carried on by international organizations.

In this and in other countries men's minds have this long while past been greatly moved by the desire to make fresh efforts to pierce the dark secrets of the forbidding Antarctic regions. Belgium has just made a brave single-handed attempt; a private enterprise sailing from these shores is struggling there now, lost for the present to our view; and this year we in England and our brethren in Germany are, thanks to the promised aid of the respective Governments, and no less to private liberality, in which this Association takes its share, able to begin the preparation of carefully organized expeditions. That international amity of which I am speaking is illustrated by the fact that in this country and in that there is not only a great desire, but a firm purpose, to secure the fullest coöperation between the expeditions which will leave the two shores. If in this momentous attempt any rivalry be shown between the two nations, it will be for each a rivalry, not in forestalling, but in assisting the other. May I add that if the story of the past may seem to give our nation some claim to the seas as more peculiarly our own, that claim bespeaks a duty likewise peculiarly our own to leave no effort untried by which we may plumb the seas' yet unknown depths and trace their yet unknown shores? That claim, if it means anything, means that when nations are joining hands in the dangerous work of exploring the unknown South, the larger burden of the task should fall to Britain's share; it means that we in this country should see to it, and see to it at once, that the concerted Antarctic expedition which in some two years or so will leave the shores of Germany, of England, and, perhaps, of other lands, should, so far as we are concerned, be so equipped and so sustained that the risk of failure and disaster may be made as small, and the hope of being able not merely to snatch a hurried glimpse of lands not yet seen, but to gather in with full hands a rich harvest of the facts which men not of one science only, but of many, long to know, as great as possible.

Another international scientific effort demands a word of notice. The need which every inquirer in science feels to know, and to know quickly, what his fellow-worker, wherever on the globe he may be carrying on his work or making known his results, has done or is doing, led some four years back to a proposal for carrying out by international coöperation a complete current index, issued promptly, of the scientific literature of the world. Though much labor in many lands has been spent upon the undertaking, the project is not yet an accomplished fact. Nor can this, perhaps, be wondered at, when the difficulties of the task are weighed. Difficulties of language, difficulties of driving in one team all the

several sciences which, like young horses, wish each to have its head free with leave to go its own way, difficulties mechanical and financial of press and post, difficulties raised by existing interests—these and yet other difficulties are obstacles not easy to be overcome. The most striking and the most encouraging features of the deliberations which have now been going on for three years have been the repeated expressions, coming not from this or that quarter only, but from almost all quarters, of an earnest desire that the effort should succeed, of a sincere belief in the good of international coöperation, and of a willingness to sink as far as possible individual interests for the sake of the common cause. In the face of such a spirit we may surely hope that the many difficulties will ultimately pass out of sight.

Perhaps, however, not the least notable fact of international coöperation in science is the proposal which has been made within the last two years that the leading academies of the world should, by representatives, meet at intervals to discuss questions in which the learned of all lands are interested. A month hence a preliminary meeting of this kind will be held at Wiesbaden; and it is at least probable that the closing year of that nineteenth century in which science has played so great a part may at Paris during the great World's Fair—which every friend, not of science only, but of humanity, trusts may not be put aside or even injured through any untoward event, and which promises to be an occasion not of pleasurable sight-seeing only, but also, by its many international congresses, of international communing in the search for truth—witness the first select Witenagemote of the science of the world.

I make no apology for having thus touched on international coöperation. I should have been wanting, had I not done so, on the memorable occasion of this meeting. A hundred years ago two great nations were grappling with each other in a fierce struggle, which had lasted, with pauses, for many years, and was to last for many years to come; war was on every lip and in almost every heart. To-day this meeting has, by a common wish, been so arranged that those two nations should in the persons of their men of science draw as near together as they can, with nothing but the narrow streak of the Channel between them, in order that they may take counsel together on matters in which they have one interest and a common hope. May we not look upon this brotherly meeting as one of many signs that science, though she works in a silent manner and in ways unseen by many, is steadily making for peace?

Looking back, then, in this last year of the eighteen hundreds, on the century which is drawing to a close, while we may see in the history of scientific inquiry much which, telling the man of science of his shortcomings and his weakness, bids him be humble, we also see much, perhaps more, which gives him hope. Hope is indeed one of the watchwords of science. In the latter-day writings of some who know not science, much may be read which shows that the writer is losing or has lost hope in the future of mankind. There are not a few of these; their repeated utterances make a sign of the times. Seeing in matters lying outside science few marks of progress and many tokens of decline or decay, recognizing in science its material benefits only, such men have thoughts of despair when they look forward to the times to come. But if there be any truth in what I have attempted to urge to-night, if the intellectual, if the moral influences of science are no less marked than her material benefits, if, moreover, that which she has done is but the earnest of that which she shall do, such men may pluck up courage and gather strength by laying hold of her garment.

We men of science at least need not share their views or their fears. Our feet are set, not on the shifting sands of the opinions and of the fancies of the day, but on a solid foundation of verified truth, which by the labors of each succeeding age is made broader and more firm. To us the past is a thing to look back upon, not with regret, not as something which has been lost never to be regained, but with content, as something whose influence is with us still, helping us on our further way. With us, indeed, the past points not to itself, but to the future; the golden age is in front of us, not behind us; that which we do know is a lamp whose brightest beams are shed into the unknown before us, showing us how much there is in front and lighting up the way to reach it. We are confident in the advance because, as each one of us feels that any step forward which he may make is not ordered by himself alone and is not the result of his own sole efforts in the present, but, is, and that in large measure, the outcome of the labors of others in the past, so each one of us has the sure and certain hope that as the past has helped him, so his efforts, be they great or be they small, will be a help to those to come.

MICHAEL FOSTER.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

REPORT OF THE PROVISIONAL INTERNATIONAL COMMITTEE.

AT the Second International Conference held in October, 1898, Professors Armstrong, Descamps and M. Foster, Dr. S. P. Langley, Professors Poincaré, Rücker, Waldeyer and Weiss were appointed to act as a Provisional International Committee, power being given to them to appoint substitutes, if any of those named were unable to serve, and also to co-opt two new members.

The delegates attending the Conference were requested to take steps in their respective countries to organize local committees charged with the study of all questions relating to the International Catalogue of Scientific Literature, and to report within six months to the Provisional International Committee. The delegates were also requested to obtain information and to report at an early date to the Provisional International Committee as to what assistance, by subscription or otherwise, towards the support of the Central Bureau may be expected from their respective countries.

The Provisional International Committee was instructed to frame a report, not later than July 31, 1899, which was to be issued by the Royal Society, and incorporated in the decisions of the Conference.

The Committee decided to co-opt an Italian and a Russian member. The Russian Government accepted the invitation, and, on the nomination of the Imperial Academy of Sciences, Mons. Th. P. Köppen, Librarian of the Imperial Public Library, St. Petersburg, became a member of the Committee.

The Committee received unofficial information that the Italian government proposed to nominate a delegate, but that he could not attend the present meeting of the Committee.

Professor Waldeyer being unable to serve, the German government appointed Professor Schwalbe in his place, but requested that he might be accompanied by Professor Klein their two delegates to have but one vote.

The Committee met in London at the Rooms of the Royal Society on August 1–5, 1899.

The following attended: Professor H. E. Armstrong, Sir M. Foster, Professor F. Klein, Mons. Th. P. Köppen, Professor H. Poincaré, Professor A. W. Rücker, Professor B. Schwalbe, Professor E. Weiss.

It was agreed—" That each country represented on the Committee has only one vote."

Reports upon the scheme for the International Catalogue prepared by the Royal Society, framed in pursuance of Resolution 21, of the Conference of 1898, which had been forwarded from the following countries, namely: Austria, Belgium, France, Germany, Netherlands, Sweden, Switzerland, United States of America, together with statements of the steps proposed to be taken for carrying out the Catalogue in India, Japan and Mexico, were received and fully considered by the Committee in the course of the meeting.

A discussion then took place on the following conditions, laid down by the German government, as those under which alone Germany was prepared to take part in the enterprise:

1. Die sachlichen Nachweise (subject entries) sollen wegfallen und in der unter III, 2 gegebenen Einschränkung durch die Anwendung mehrfacher Ordnungssymbole ersetzt werden.

2. Bei der Festlegung der den Titeln im System zukommenden Plätze durch Ordnungssymbole soll im Allgemeinen die Regel gelten, dass jeder Titel nur an einer Stelle unterzubringen ist.

3. Der sachlich geordnete Theil der Buchausgabe soll in allen Disziplinen lediglich aus den Titeln zusammengestellt werden, und zwar ausnahmslos unter Voranstellung des Verfassernamens.

4. Die Zettelausgabe soll als offizieller Theil des Unternehmens wegfallen.

5. Die Beitrittserklärung soll zunächst nur auf fünf Jahre erfolgen.

It was Resolved:

1. That the issue of a Card Catalogue be postponed for the present.

2. That a paper shall be entered in the Catalogue in more places than one only when this is rendered desirable by its scientific contents. No exact limits to the numbers of entries to be allowed to single papers can at present be fixed. This must be determined by the Central Bureau after adequate experience. Until such limits are determined, if the Central Bureau is of the opinion that in the returns made by any regional bureau the numbers of entries to single papers do not correspond to the scientific contents, it shall be its duty to intervene; such intervention, however, to be based not on individual cases, but upon an average. As regards the order of arrangement of entries in the final sub-divisions, in general this shall be in accordance with authors' names, except the subject demand other treatment.

The English members thereupon made the following statement:

The conditions under which the German Government agree to take part in the establishment of the Catalogue, viz.:

(A) That in general each title should be entered in one place only; and

(B) That 'subject entries' and 'significant words' must not be used,

differ so materially from the scheme formulated by the two Conferences, and so seriously affect the whole character of the enterprise, that the English members feel that they have no power to accept them without consulting the Royal Society upon the matter.

With respect to (A), if the condition be interpreted in accordance with the decision arrived at by the International Committee in Resolution 2 (see above), the difficulty is materially lessened.

With respect to (B), however, they feel sure that the restriction of entries to titles only will so largely diminish the value of the Catalogue, bringing it below that of various indices and reports already existing, and hence so lessen the sale as to render the financial success of the enterprise extremely doubtful, if not impossible.

They quite understand the reasons which have led the German Government to pro-

pose the restrictions in question, but they are of opinion that those reasons do not necessarily hold good for all countries.

And the objections which they entertain to the proposal would be lessened if liberty were given to individual Regional Bureaux when they find it necessary or desirable, in one or more of the places in which a paper is referred to, to make use of modified titles describing the contents of the paper better than the title itself. The extent to which such use of modified titles can be made must, of course, be subject to the control of the International Catalogue Council.

The English members cannot assume that even if it be thus changed, the conditions proposed by the German Government will be accepted by the Royal Society; but they desire, before bringing the whole matter before the Royal Society, to be informed of the views of the German Government in respect to the proposed change.

Moreover, so grave a departure from the scheme for providing a Catalogue, which should unquestionably be the best of its kind, could only be recommended if all the principal countries also consent. In particular, as the American delegate was unfortunately unable to attend the Conference, it will be necessary that the whole question at issue should be communicated to him, and that American opinion should be ascertained.

The German delegates expressed their willingness to submit this statement to their Government.

It was Resolved:—That separate schedules shall be provided for the following branches of science:

A. Mathematics.
B. Mechanics.
C. Physics.
D. Chemistry.
E. Astronomy.
F. Meteorology (including Terrestrial Magnetism).
G. Mineralogy (including Petrology and Crystallography).
H. Geology.
J. Geography (Mathematical and Physical).
K. Paleontology.
L. General Biology.
M. Botany.
N. Zoology.
O. Human Anatomy.
P. Physical Anthropology.
Q. Physiology (including Psychology, Pharmacology and Experimental Pathology).
R. Bacteriology.

And that the branches of Science be indicated by the letters of the alphabet in consecutive order as registration letters.

Schemes for Physics, Mineralogy, Petrology, Crystallography, Geology, Paleontology, Geography, Botany, Zoology and Physiology were adopted; and schemes for Mathematics, Mechanics, General Biology, Chemistry, Human Anatomy, Psychology, Bacteriology, Physical Anthropology, Astronomy and Meteorology were also approved for adoption, subject to the introduction of minor alterations by Committees to whom they were referred with the instruction to complete such revision and return the schemes to the Royal Society by the end of September at latest.

A general introductory section common to all sciences was adopted.

It was agreed that complete lists of new species would be required in the case of several of the sciences.

With reference to the cataloguing of the applications of science—

It was Resolved:—That technical matters of scientific interest shall be included in the catalogue, but shall be referred to under the appropriate scientific headings.

It was Resolved:—That a general list of journals indexed in the Catalogue, with the abbreviations to be used as references, be issued with the first edition of the Catalogue, and that a supplement giving the additions to this list be issued annually;

and a new edition at the end of five years.

With regard to the frequency of publication of the parts of the Catalogue, it was agreed:

(1) That a volume in each subject be published at least once a year.

(2) That it is desirable that in certain sciences there shall be a bi-monthly or quarterly issued of the Subject Catalogue.

It was Resolved:—That the registration system proposed by the Royal Society be adopted for tentative use in the Catalogue; and that an alphabetical key of the schedules of classification similar to that illustrated in the Netherlands report shall be issued with each annual volume together with the appropriate schedule, printed in the official languages, to be supplied as may be required.

The establishment of the Central Bureau having been considered:

"It was agreed to recommend that the Royal Society be requested to organize the Central Bureau and to do all work, including framing estimates and obtaining tenders, preliminary to the publication of the Catalogue in 1901; but that it shall act in concert with the International Council so soon as this shall be established."

The English members of the Committee made the following statement with reference to this resolution:

Previous to the actual issue of the Catalogue, the following money responsibilities must be incurred:

(1) Initial expenses connected with the Central Bureau, such as securing rooms, furniture, payment of officials before the first issue, etc.

(2) Contracts for printing the catalogue and other contracts which it may be necessary to make. With respect to the contracts, they could probably be obtained more cheaply if made for the whole of the five years for which the experiment of issuing the catalogue is to be tried. It would be very difficult to make, for one year only, contracts which may involve the purchase of new machinery, etc., by the printer. The total financial responsibility thus incurred cannot be estimated at less than £10,000. Moreover, it is possible, though we hope improbable, that the scheme may fail, and that the various countries concerned may wish to abandon it. The question therefore arises, who is to be responsible for any sums which might in such a case be due to the printer, or to others with whom contracts had been made?

The question has been raised whether the Royal Society would be willing to act in the matter.

On this we must remark that even if the Society were to act as a Provisional International Council, no contracts can be signed until after the next Conference (presumably held at Easter, 1900) has decided whether bi-monthly or quarterly parts shall be issued, or whether the total sum to be spent annually shall be limited to a fixed amount.

Hence, no great saving of time would result even if the Royal Society were willing to take a very heavy responsibility. On the whole, therefore, we propose that if and when the regions represented on the Provisional International Committee have assented to its proposals, these proposals shall be communicated to all the countries represented at the last Conference, that they shall be asked to organize their Regional Bureaux and nominate their representatives on the International Council in anticipation of the result of the next Conference, and that the International Council should meet immediately after the Conference.

This International Council would then take up, together with the management, all the necessary financial responsibilities.

Meanwhile the Royal Society would undertake all preliminary steps, obtain tenders,

and lay them before the International Council at its first meeting.

If this would allow the first issue to take place early in 1901, the desired object will be gained, but no greater speed will be attained by entrusting more responsibility to the Royal Society as it could not make definite contracts till after the next Conference.

It was agreed that the resolution preceding this statement shall be interpreted in accordance therewith.

The English members of the Committee undertook to bring the resolution under the notice of the Royal Society, and the other members to call the attention of their governments thereto.

After full consideration, the following statement as to the financial position was adopted:

The finances of the Catalogue will be controlled by the International Council, which, in accordance with regulations adopted by the International Conference of 1898 (Report 27, p. 11), will be bound to "make a report of its doings, and submit a balance sheet, copies of which shall be distributed to the several Regional Bureaux, etc."

The plan which seems the most generally favored is that the contributions of the Regional Bureaux shall take the form of undertakings to purchase a certain number of copies of the Catalogue annually. Various estimates point to the fact that the average contribution thus made by Regional Bureaux of the first rank (which may be called a whole share) will be equivalent to between one-eighth and one-tenth of the whole cost of producing the Book Catalogue.

For the purposes of this report, sales to private persons are not considered, or are supposed to be included in the sum guaranteed by each constituent country. In some cases the Regional Bureau will probably sell to individuals, either directly or through a publisher, those volumes which it does not dispose of to institutions, and will thus take the risk of the private sales. Whether this plan be adopted elsewhere or not, it is essential that the number of copies which constituent countries undertake to purchase shall together cover the cost of the production of the Catalogue.

Taking the original estimate formed by the Royal Society, the cost of the Book Catalogue would be £5,600 annually, so that a whole share would be between £700 and £560 per annum. If the lowest remunerative number of sales is equivalent to 350 complete subscriptions at £16 each, this would mean that a whole share entailed the purchase of between 44 and 35 complete sets or an equivalent.

These figures are, however, based upon assumptions which will require revision. The Card Catalogue will, no doubt, be abandoned, and it is proposed that it should be replaced by bi-monthly or quarterly issues. This, therefore, is an expense which has not been allowed for. The number of volumes has been increased from 16 to 17. There is also a general opinion that the estimates of the number of papers to be dealt with on which the original financial estimates were based were too small. Until all these matters have been fully considered and fresh estimates prepared, it appears to be impossible to say more than that it is hoped that the cost of a whole share will not be very much greater than the original estimates.

Estimates on the new conditions will be prepared and circulated during the autumn.

There are, however, three other points to consider:

It will be necessary to establish the Central Bureau and to appoint the officials some months before the first issue of the Catalogue begins. Funds for this purpose, which may be estimated at £2,500, are not included in the annual balance sheet which alone has been prepared.

Further, serious responsibility may also arise on the points referred to in the above statement of the representatives of the Royal Society.

Again, if the subscriptions are paid at the end and not at the beginning of the first year, it will be necessary to borrow funds, the interest on which will be a charge on the undertaking.

Again, if some countries refuse to form Regional Bureaux or to join in the enterprise, their literature will have to be dealt with by the Central Bureau. The cost of this cannot be estimated until it is definitely known whether the International Catalogue will be universally supported.

It was agreed that in reporting to the various governments and bodies concerned, special stress should be laid on the importance of organizing Regional Bureaux without delay.

The English delegates were requested:

(1) To have the schedules approved by this Committee reprinted and issued as soon as possible.

(2) To prepare an amended estimate of the cost of the Catalogue.

(3) To issue a complete programme based on the proceedings of the two Conferences and of this Committee.

(4) To fully inform all countries whose coöperation is desired.

It was agreed to recommend:

(1) That an International Conference, to arrive at a final decision on all matters concerning the Catalogue, be held at Eastertide, 1900.

(2) That the delegates attending this Conference should be charged with full powers to determine both financial and other questions.

(3) That those chosen to act on the International Council should be delegates to this Conference.

It was agreed—

"That the members of the Committee be requested to endeavor to obtain from their respective Governments authority to place themselves in direct communication with the Royal Society, as the official channel of communication for all further provisional correspondence on the subject of the Catalogue."

Henry E. Armstrong.
M. Foster.
F. Klein.
Th. P. Köppen.
H. Poincaré.
Arthur W. Rücker.
B. Schwalbe.
E. Weiss.

August 5, 1899.

SECTION E.—GEOLOGY AND GEOGRAPHY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The address of the Chairman, Mr. J. F. Whiteaves on 'The Devonian System in Canada' has already been printed in Science. The papers presented were as follows:

'The Geology of Columbus and Vicinity,' Edward Orton, Columbus, Ohio.

An informal presentation of the facts in connection with the geology of Columbus and vicinity, designed to suggest points, of special interest to the visiting geologists. One matter to which particular attention was called was the occurrence of bowlders of native copper, derived from the Keewenaw copper region. Blocks of Marquette iron ore have also been sparingly found.

'Glacial phenomena of Central Ohio,' Frank Leverett, Denmark, Ohio.

A general description of the glacial and interglacial formations of Central Ohio, designed, in part, to cover the region in the vicinity of Lancaster, Ohio, to which an excursion was subsequently made.

The formations recognized in the description are:

1. The Illinoisan drift; 2. A soil and weathered zone (Sangamon) formed on

the surface of the latter; 3. A silt deposit, probably of Iowan age, which caps the weathered surface of the Illinoisan drift; 4. The Wisconsin drift with its several moraines. Lobation of the ice sheet in the Scioto basin; direction of striæ, and changes of drainage produced by glaciation are also discussed.

'Lateral Erosion at the Mouth of the Niagara Gorge,' G. Frederick Wright, Oberlin, Ohio.

The results of an accurate survey of the east face of the gorge are given, affording an opportunity to compare the present face of the gorge with that presented in 1854 and furnishing a standard datum for future comparisons. The rate of erosion thus determined seems to favor shorter chronologies for the age of the gorge.

'Age and Development of the Cincinnati Anticline,' August F. Foerste, Dayton, Ohio.

Along the axis of the Cincinnati anticline, from Stanford in Lincoln County to near Lebanon in Marion County, Kentucky, the Devonian rests on the Ordovician. On the western flank of the anticline the Devonian rests, first on the lowest member of the Silurian (the Clinton) then on the successively higher members, the Niagara, Osgood shale, Laurel limestone, Waldron shale and Louisville limestone. On the eastern flank it rests first upon the Clinton next upon the Osgood shales. The formation of the anticline began previous to the deposition of the Devonian. Its growth was arrested during late Silurian and early Devonian times and a large area above sea level was reduced to a peneplain. On this peneplain the Devonian limestone was subsequently deposited, but unevenly, owing to the inequalities of the peneplain. The Devonian black shale however was deposited over the entire anticline. This formation contains marine fossils at its base and land plants over the anticline region. These are generally believed to be the remains of the earliest land plants. After the deposition of the Devonian the folding continued, the maximum taking place in post-Devonian times. The facts seem to indicate that the anticline was not in existence during Clinton and Osgood times, but that it began in late Silurian to early Devonian time and had its maximum development in post-Devonian time.

'The Silurian-Devonian Boundary in North America,' Henry S. Williams, New Haven Conn.

'The Section at Schoharie, N. Y., John J. Stevenson, New York, N. Y.

'The Geological Results of the Indiana Coal Survey,' George H. Ashley, Indianapolis, Ind.

'The Cape Fear Section in the Coastal Plain,' J. A. Holmes, Chapel Hill, N. C.

'Triassic Coal and Coke of Sonora, Mexico,' E. T. Dumble, Houston, Tex.

'Some Geologic Conditions Favoring Water Power Developments in the South Atlantic Region,' J. A. Holmes, Chapel Hill, N. C.

The 'fall line' between the coastal plain and the Piedmont plateau is the zone where the most favorable geologic conditions for the development of water power are found. In the region of the crystalline schists the lesser geologic boundary lines, separating belts of slates, schists, granites, etc.; shearing lines or zones and fault lines, supply favorable conditions on a smaller scale. Within certain areas of bedded or schistose rocks, variations in the composition and obduracy of the rock masses furnish suitable conditions.

(*a*) '*Paropsonema:* A Peculiar Echinoderm from the Intumescens Fauna, New York.'

(*b*) 'Remarkable Occurrence of Orthoceros in the Oneonta Sandstones of New York.'

(*c*) 'The Squaw Island Water Biscuit, Canandaigua Lake, New York.'

John M. Clarke, Albany, N. Y.

Paropsonema represents an extraordinary type of echinoderm structure. It is believed to be an echinoid. The description was illustrated with drawings.

Extending over several square miles in the Chenango Valley, N. Y., a stratum of Oneonta sandstone occurs, in which are found thousands of *Orthocerata* standing erect and perpendicular to the bedding planes. They are the only truly marine organisms in the sandstone. Specimens were shown.

The so-called 'water biscuit' are probably concretions due to the effect of aquatic vegetation of low order, producing a precipitation of lime from the water. Specimens were shown.

'The Pot Holes of Foster's Flats (now called Niagara Glen) in the Niagara River,' Miss Mary A. Fleming, Buffalo, N. Y.

The discovery of pot holes at Foster's Flats is recorded, together with their location and the general appearance of the surroundings. They occur in large fragments which have fallen from the adjacent cliffs and were apparently formed while the fragments were part of the cliffs.

'A Consideration of the Interpretation of Unusual Events in Geologic Records, Illustrated by Recent Examples,' Frederick W. Simonds, Austin, Tex.

An examination of geologic reports shows that, as a rule, the working geologist devotes too little time to the *interpretation of events*, while recording facts. The value of stratigraphic work is not questioned, but the value of interpretation should not be underestimated. Proper interpretation of unusual events is not only difficult, but an improper interpretation may be exceedingly misleading and be conducive to error in other directions.

'The Pre-Lafayette (Tennessean) Base-level,' W J McGee, Washington, D. C.

The most extensive base-level of the North American continent is that preserved in part as an unconformity beneath the Lafayette formation, and in part as a somewhat dissected surface, extending inland from the margin of the formation. This base-level is the record of a vast period of approximate continental stability, which has been called the Tennessean.

'The Relative Ages of the Maumee Glacial Lake and the Niagara Gorge,' Chas. E. Slocum, Defiance, Ohio.

The time thought necessary for the eroding of the Niagara Gorge has been shortened by recent observers until now 7,000 to 7,500 years is believed to be sufficient. The Ice Age was probably well over before the waters began to erode the gorge. The level of Lake Erie has been little, if any, lowered by the gorge. The Maumee Glacial Lake was well drained before the Niagara River channel was worn, and the ice must have disappeared from the Lake Erie region previous to this—that is to say the Maumee Glacial Lake may have existed several thousand years before the erosion of the Niagara gorge began.

'The Galt Moraine and Associated Drainage,' F. B. Taylor, Fort Wayne, Ind.

In Canada, west of Lake Ontario, extending northeast from Paris, past Galt to Credit Forks, is about fifty miles of moraine, called the Galt moraine, and fragments of two others to the west and east. The Galt moraine in its northern part is on or close to the escarpment which runs north from Hamilton. A large river carried the glacial waters to the southwest along the front of the moraine in its early stages of formation. The bed of this river is well marked. As the ice receded the moraine was deposited, the river changed its course and for a time ran between the ice and the moraine. For several miles the bed is on the brink of the escarpment. Along that part there is no bank on the east side of the bed, but a descent of over 200 feet to the Credit river.

Further down, the river turned to the west, cut a deep channel through the moraine and joined its earlier bed at Eden Mills. In the earlier stages of the moraine the river took a southwest course from Preston past Ayr, but in the last stages a lower course was found through the moraine, longitudinally past Galt and Paris. In most of its course the flow was rapid enough to carry away most of the drift and leave the limestone ledges bare. In the broader portions it deposited cobble stones and gravel. Drumlins cover the northern part of the area in question. Further work will be necessary to show the relation between the moraines and those of western New York or those of the west side of the Ontario peninsula.

'Glacial and Modified Drift in Minneapolis, Minn.,' Warren Upham, St. Paul, Minn.

Red drift from the Lake Superior region is overlapped by bluish drift from the Red River valley and Manitoba. The final melting of the ice sheet laid bare the area occupied by glacial Lake Hamline, just east of Minneapolis, between tract of ice thus flowing from northeast and northwest. In the eastern part of Minneapolis a terminal moraine, consisting mostly of northeastern drift, was formed in the border of the western ice tract. It is evidence that the glacial current from the west pushed back that from the east, near the close of the Ice Age. The sand plain of the Mississippi Valley here was deposited near the front of the ice, when it retreated westward from this moraine, and a wide esker ridge, two miles long, formed at the same time, lies in the southwest part of the city. Frequent banding and intermingling of the red and bluish tills indicate that they were englacial.

'The Ozarkian and its Significance in Theoretic Geology,' Joseph Le Conte, Berkeley, Cal.

The name Ozarkian was coined to commemorate the erosive work in the Ozark Mountain region during a long and important epoch directly preceding the ice invasion of the Quaternary. The Ozarkian is characterized by elevation and erosion, the Glacial by ice accumulation and drift deposits, the Champlain by depression and stratified deposits. During the earth's history there have been certain well defined critical periods, characterized by great and widespread changes in the earth's crust, in its climate, or in its organic forms. They separate the primary divisions or eras of geologic time (Paleozoic, Mesozoic, Cenozoic), and such another era I am convinced is now commencing, which I have called the Psychozoic. The Quaternary period represents the critical or transition period between the Cenozoic and Psychozoic Eras, when man was *introduced.* The Ozarkian is the first epoch of this critical period. Man subsequently became *established* as the dominant factor in the earth's life history and the Psychozoic era began.

'The Discovery of New Invertebrates in the Dinosaur Beds of Wyoming,' Erwin H. Barbour and W. C. Knight, Lincoln, Nebr.

Some eight or ten new invertebrates, all apparently fresh water forms, recently discovered in the Dinosaur beds of Wyoming tend to confirm the belief that these beds are of fresh-water origin. The writer also noted about six species of lamellibranchs and gasteropods. Associated with the invertebrates are also crocodilian teeth and bones.

'The Rapid Decline of Geyser Phenomena in the Yellowstone National Park,' Erwin H. Barbour, Lincoln, Nebr.

To those who visit the geyser region frequently the rapid decline of geyser activity seems startling. From superficial observation it seems safe to assume that if the decline of activity noted during the past four years should continue for the next eight or ten years the features which most impress

the geologist will have disappeared. At the mammoth hot springs the activity is not one-tenth that of former times, Minerva Terrace having become extinct (since 1895); the discharge from Pulpit and Jupiter Terraces having greatly declined during the same period and the Narrow Gauge—a fissure vent—and other attractions, having become all but extinct. Roaring Mountain is now silent though steaming. In the Norris Geyser Basin the Black Growler is less active. In the Lower Basin the splendid Fountain Geyser is extinct, with a feeble substitute near by, called the Dewey. The Giant Paint Pots are greatly contracted in size—the pink half being extinct. In the Upper Basin some of the better known as well as many of the lesser geysers are extinct or supposed to be. Among these are the Splendid Geyser and the Beehive Geyser. The Grand Geyser, which used to erupt daily, now erupts irregularly about three times a season. The Cascade, which erupted about every quarter of an hour in 1895 now erupts once a day.

The general impression of frequenters of the Park is that the changes are serious and much more rapid than is generally believed.

'Greatest Area and Thickness of the North American Ice Sheet,' Warren Upham, St. Paul, Minn.

From the overlapping and intermingling of the drift deposits the indications are that the ice sheet at its culmination reached continuously across the continent from New England to British Columbia or southeastern Alaska, interrupted only in its southern part by the projecting ranges of the Rocky Mountains. The conclusions of Dr. G. M. Dawson that the Cordilleran glaciation mainly preceded the glaciation of the Laurentine region and of the great plains stretching westward nearly to the Rocky Mountains, and that the maximum extension of the Laurentide ice sheet was attended by a depression of the Cordilleran region, with a subsequent elevation of about 5,300 feet, is not apparently borne out by the facts. The probabilities seem to be that the Cordilleran and Laurentide ice sheets, having been each accumulated because of high continental altitude much exceeding that of the present time, were confluent along the east side of the Rocky Mountains, a continuous ice sheet at the north extending from the east to the west side of the continent.

In Minnesota and North Dakota observations on each side of the Glacial Lake Agassiz oppose the view of Tyrrell that the Laurentide ice sheet was preceded by a Keewatin ice sheet. Facts in connection with glacial lake deltas and overlapping drift deposits demonstrate contemporaneous glaciation meeting from the northwest and northeast. There is also evidence that the northwestern ice field, belonging to the Keewatin of Tyrrell, pushed back the northeastern ice field, referable to the Laurentide, showing that there the greatest extension of the Keewatin was later. From the northwest and northeast, however, the two ice fields were confluent. This great ice sheet northward, as evidenced by the height of mountain glaciation, attained a maximum thickness of one to two miles nearly across the continent, the thickness being greatest upon the Laurentide highlands.

ARTHUR HOLLICK,
COLUMBIA UNIVERSITY. *Secretary.*

SCIENTIFIC BOOKS.

Catalogus Mammalium tam viventium quam fossilium. By DR. E. L. TROUESSART. Berlin, R. Friedländer & Sohn. New ed., fasciculus VI., Appendix and Index, 1899, 8° pp. 1265–1469. Price of complete work 66 Marks.

The completion of the great 'Catalogus Mammalium' which Dr. Trouessart has been publishing in parts during the past two years marks an epoch in systematic work in mammals. Previous catalogues, incomplete at best, have been restricted either to living or extinct forms, so that zoologists have been obliged to

consult one set and paleontologists another. But as Professor Osborn has recently remarked: "Among the vertebrates the separation of the living and extinct forms is at present a calamity. Zoologists must become familiar with paleontology whether they prefer to do so or not. It is impossible, for example, to understand the modern races of dogs without studying the Oligocene races and their ancestors."* Dr. Trouessart has sought to remedy this defect by bringing together in one list all the species of mammals, living and extinct, which have been described between 1758 (the date of publication of the 10th edition of the 'Systema Naturæ' of Linnaeus) and the close of the year 1898—a period covering exactly a century and a half.

The first three parts of this catalogue have already been reviewed in these pages;† without attempting to treat the others with the same detail, attention may be called to a few points which are suggested more especially by the last brochure. The catalogue proper consists of 5 parts containing 1,264 pages, while fasciculus VI. is devoted entirely to addenda and corrigenda (94 pp.) and a closely printed 3 column index of 109 pages.

The index has some 16,827 entries indicating that over 16,000 names have been listed; of these 2,977 are generic and 13,850 specific. The total number of recognized genera and subgenera is 1,840; of recognized species about 7,500. These numbers are significant as an index of progress in the study of mammals. In 1758, 39 genera and 183 species were described by Linnaeus; in 1798 the total number of recognized genera was less than 100 of which only 1 was extinct; while in 1898 the number of genera and subgenera recognized by Trouessart is 1,840. This rapid increase in names within the present century has resulted from the more thorough exploration of all parts of the globe, more careful study of improved material, and especially from the marvelous development in our knowledge of extinct forms.

Naturally the naming of so many species has presented many difficulties and even a superficial examination of the catalogue shows many curiosities of nomenclature. The names vary in length from one to ten syllables, the shortest being *Mus rex* and the longest *Brachydiastematotherium transsylvanicum*. The tendency to repeat favorite specific names in many groups is very noticeable; *major* has been applied to 51 species, *intermedius* to 54, *robustus* to 56, *gracilis* to 65, and *minor* to 71. Many species have been named in honor of eminent naturalists; the zoologists who have had a dozen or more mammals named after them are: Blanford, 12; Allen, Gray and Lartet each, 13; Gervais and Owen, 15; Geoffroy, 17; Gaudry, 20; Milne Edwards, 21; and Cuvier, 28.

That such a catalogue necessarily contains some errors is self-evident, but the wonder is that there are not more of them. There are of course omissions (*e. g.*, a genus, subgenus and 5 species of phyllostome bats described by Miller in the Proceedings of the Philadelphia Academy Science, in July, 1898); errors in the authority of genera and species and in the authors of papers (*e. g.*, in crediting Bailey's 'List of Mammals of the District of Columbia' to Bangs); adoption of the wrong names for groups, thus differentiating forms which are identical while reducing others to synonomy which are really distinct. But the care which the author has taken to eliminate errors of all kinds is shown by the voluminous appendix of 94 pages devoted to corrections and additions of genera and species which were omitted, or which have been described during the two years in which the catalogue has been passing through the press.

The most serious defect in the catalogue seems to be in the treatment of genera. References are so seldom given that it is difficult to consult the original descriptions. Moreover the 2,977 generic names indexed probably do not represent much more than 65 per cent. of those actually published, so that in some cases names which have the best claim to adoption are not even mentioned. It should be stated that the author's aim has been to adopt the best known or most generally used name for a genus, on the plea that the work would thus be more generally useful—in short he has in many cases followed the *auctorum plurimorum* rule rather than the law of priority. He has thus been led to

*Science, N. S., X., p. 171, August 11, 1899.

†Science, N. S., VI., pp. 68–69, July 9, 1897; VII., pp. 30–33, January 7, 1898.

adopt some names which are preoccupied, but in this respect there is a marked improvement in the latter part of the catalogue. The selection of the best known designation, regardless of whether the name is preoccupied or antedated, is likely to lead to more trouble than convenience in the long run. Changes in names are always objectionable, particularly in higher groups, but it is safe to say that nearly 5 per cent. of all the genera and subgenera in this catalogue are likely to undergo change within a few years. Dr. Trouessart might have prevented much trouble for students in future by making the changes now demanded by the law of priority. Even if he preferred to adopt the other course in the body of the list, a table might have been inserted in the appendix showing the earliest names of groups for which he had selected the best known designation, but even this seems to have been impracticable on account of the undue length of the appendix.

Without attempting to give such a table here, it will suffice to illustrate this point by mentioning 50 genera and subgenera which have not been corrected in the appendix. It should be explained, however, that these do not by any means include all the names which rest on an unstable basis. Full references are added, as some of the genera are not given in the catalogue, although the majority of them are mentioned in synonymy with merely authorities and dates.

Page 4. For *Siamanga*, 1843—substitute **Symphalangus** Gloger, Hand- u. Hilfsb. Naturgesch., I., p. 34, 1841.

P. 44. For *Brachyurus*,* 1823—**Cacajao** Lesson, Species des Mamm., pp. 181–183, 1840.

* Trouessart's *Brachyurus* contains two subgenera: A, *Ouakaria* Gray, 1849 and B, *Brachyurus*. Since *Brachyurus* Spix, 1823, is preoccupied by *Brachyurus* Fischer, 1813, a group of field mice, the genus becomes *Cacajao* Lesson, 1840, and subgenus A, *Ouakaria* also becomes *Cacajao* both being based on *Simia melanocephala*. Subgenus B, *Brachyurus* including the redfaced species, if really worthy of separation, apparently requires a new name and may be called *Cothurus* (docked tail). *Ouakaria* is not available for this group as it has already been restricted to the blackheaded forms and *Cercoptochus* Gloger, 1841, based on the uakaris in general, must be restricted to the same group since it was proposed before any of the redfaced species had been described.

P. 44. For subgenus *Brachyurus* Trouessart—**Cothurus** nom. nov. Type *Brachyurus calvus* Geoff.

P. 46. For *Chrysothrix*, 1835—**Saimiri** Voigt, Cuvier's Thierreich, I., p. 95, 1831.

P. 47. For *Nyctipithecus*, 1823—**Aotus** Humbolt, Recueil Obs. Zool. Anat. Comp., I., pp. 306–311, 358, 1811.

P. 62. For *Cheiromys*, 1799—**Daubentonia** Geoffroy, Décad. Philos., IV., p. 193, 1795.

P. 66. For *Hemigalago*, 1857—**Galagoides** Smith, S. Afr. Quart. Journ., 2d ser., II., p. 32, 1833.

P. 84. For *Cynonycteris*, 1852—**Rousettus** Gray, London Med. Repos., XV., p. 299, 1821.

P. 90. For *Megaloglossus*,* 1885—**Trygenycteris** Lydekker, in Flower & Lydekker's, Mamm. Living & Extinct, p. 655, 1891.

P. 135. For *Furia*,* 1828—**Furipterus** Bonaparte, Icon. Fauna Italica, I., fasc. XXI. (under *Plecotus auritus*), 1837.

P. 149. For *Mystacina*,* 1843—**Mystacops** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 671, 1891.

P. 152. For *Macrotus*,* 1843—**Otopterus** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 673, 1891.

P. 153. For *Lophostoma*, 1838—**Tonatia** Gray, Griffith's Cuvier, Anim. Kingdom, V., p. 71, footnote, 1827.

P. 155. *Tylostoma*,* 1855—**Anthorhina** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 674, 1891.

P. 156. For *Carollia*,* 1838—**Hemiderma** Gervais, Expéd. Comte de Castelnau l'Am. du Sud, Mamm., p. 43, 1855.

P. 158. For *Ischnoglossa*,* 1860—**Leptonycteris** Lydekker, in Flower & Lydekker's, Mamm. Living & Extinct, p. 674, 1891.

P. 203. For *Mygale*, 1800—**Desmana** Güldenstädt, Beschäft. Berliner Gesellsch. Naturf. Freunde, III., p. 108, 1777.

P. 212. For *Centetes*, 1811—**Tenrec** Lacépède, Buffon's Hist. Nat., Didot ed., Quad., XIV., p. 156, 1799.

P. 248. For *Cercoleptes*, 1811—**Potos** Cuvier & Geoff., Mag. Encyclopédique, II., p. 187, 1795.

P. 287. For *Enhydra*,* 1822—**Latax** Gloger,

* Preoccupied.

Nova Acta Acad. Cæs. Leop.—Carol., XIII., pt. 2, p. 511, 1827.

P. 297. For *Hypotemnodon*, 1894—**Mesocyon** Scott, Princeton College Bull., II., p. 38, 1890.

P. 341. For *Hemigalidia*, 1882 — **Salanoia**, Gray, Proc. Zool. Soc. London, pp. 523–524, 1864.

P. 372. For *Callorhinus*,* 1859—**Callotaria** Palmer, Proc. Biol. Soc. Wash., VII., p. 156, 1892.

P. 375. For *Trichechus*,* 1766—**Odobenus** Brisson, Regnum Anim., 2d ed., pp. 12, 30–31, 1762.

P. 377. For *Macrorhinus*,* 1826—**Mirounga** Gray, Griffith's Cuvier, Anim. Kingdom, V., pp. 179–181, 1827.

P. 380. For *Ogmorhinus*, 1875—**Hydrurga** Gistel, Naturgesch. Thierreichs, p. XI., 1848.

P. 421. For *Macroxus*, 1823—**Guerlinguetus** Gray, London Med. Repos., XV., p. 304, 1821.

P. 453. For *Myoxus*, 1780 — **Glis** Brisson, Regn. Anim., 2d ed., pp. 13, 113–118, 1762.

P. 724. For *Euprotogonia*, Apr. 1893—**Tetraclænodon** Scott, Proc. Acad. Nat. Sci., Phila., Nov. 1892, pp. 299–300.

P. 754. For *Ceratorhinus*, 1867—**Didermocerus**† Brookes, Cat. Anat. and Zool. Museum, p. 75, 1828.

P. 817. For *Dicotyles*, 1817 — **Tayassu** G. Fischer, Zoognosia, III., pp. 284–289, 1814.

P. 835. For *Oreodon*,* 1851—**Merycoidodon** Leidy, Proc. Acad. Nat. Sci., Phila., pp. 47–50, 1848.

P. 896. For *Furcifer*,* 1844—**Hippocamelus** Leuckart, De Equo bisulco Molinæ, p. 24, 1816.

P. 950. For *Hippotragus*, 1846 — **Ozanna** Reichenbach, Vollst. Naturgesch. In- u. Auslandes, Säugeth., III., pp. 126–131, 1845.

P. 967. For *Aploceros*, 1827—**Oreamnos** Rafinesque, Am. Monthly Mag., II., p. 44, 1817.

P. 1000. For *Manatus*, 1772—**Trichechus** Linnæus, Syst. Nat., ed. 10, I., p. 34, 1758.

P. 1003. For *Eotherium*,* 1875—**Eotheroides** nom. nov. *Eotherium* Owen is preoccupied by *Eotherium* Leidy, 1853, a genus of Perissodactyla.

* Preoccupied.

† If this name is considered invalid because published in a sale catalogue, the subgenus stands *Dicerorhinus* Gloger, 1841.

P. 1007. For *Halicore*, 1811—**Dugong** Lacépède, in Buffon's Hist. Nat., Didot ed., Quad., XIV., p. 193, 1799.

P. 1008. For *Rhytina*, 1811—**Hydrodamalis** Retzius, Kongl. Vet. Acad. nya Handl., Stockholm, XV., p. 292, 1794.

P. 1009. For *Zeuglodon*, 1839—**Basilosaurus** Harlan, Trans. Am. Philos. Soc., new ser., IV., pp. 397–403, 1834.

P. 1016. For *Argyrodelphis*, Apr., 1894—**Diochotichus** Ameghino, Énum. Syn. Mamm. Foss. Eocène Patagonie, p. 182, Fev. 1894.

P. 1017. For *Pontistes*, 1885—**Palaeopontoporia** Doering, Exped. Rio Negro (Patagonia), III., Geol., pp. 437, 455, 1882.

P. 1037. For *Tursio*,* 1830—**Lissodelphis** Gloger, Hand- u. Hilfsbuch Naturgesch., I., p. 169, 1841.

P. 1042. For *Neomeris*,* 1846—**Neophocæna** Palmer, Proc. Biol. Soc. Wash., XIII., p. 23, Jan., 1899.

P. 1048. For *Orca*,* 1846 — **Orcinus** Fitzinger, Wiss.- pop. Naturgesch. Säugeth, VI., pp. 204–217, 1860.

P. 1120. For *Tamandua*,† 1842—**Uroleptes** Wagler, Nat. Syst. d. Amphibien, p. 36, 1830.

P. 1121. For *Cyclothurus*,† 1842—**Cyclopes** Gray, London Med. Repos., XV., p. 305, 1821.

P. 1146. For *Lysiurus*, 1891 — **Cabassous** McMurtrie, Cuvier's Anim. Kingdom, I., p. 164, 1831.

P. 1261. For *Echidna*,* 1798—**Tachyglossus** Illiger, Prod. Syst. Mamm. Avium, p. 114, 1811.

P. 1263. For *Proehidna*, Nov., 1877 — **Zaglossus** Gill, Ann. Record Sci. & Industry for 1876, p. CLXXI., May, 1877.

This list of exceptions to the generic names which Dr. Trouessart has adopted should not be considered as a reflection on the value of his work. Its main object is to illustrate the author's method of selecting names and to call attention to some of the earliest ones which do not happen to be now in common use. It has been prepared to increase, if possible, the usefulness of the work rather than to detract from it.

So far as species are concerned the catalogue is evidently much more complete, although, as

* Preoccupied.

† Usually quoted as 1825, but in reality a *nomen nudum* previous to 1842.

pointed out above, there are a few omissions. There is, of course, room for diversity of opinion concerning the validity of some of the species which are given recognition, but no one can be personally familiar with the characters, history and synonomy of such a multitude of forms, and all that the author could do was to take the latest revision of each group as his guide. In adopting this course he has done all that could be expected and has produced a valuable *résumé* of the labors of specialists in many groups.

In fact, too much can hardly be said in favor of the catalogue. It represents an enormous amount of painstaking labor and will long remain a monument to the industry, patience and bibliographical skill of its author. It is indispensable to the student of mammals and its chief drawback is, perhaps, its high price (66 Marks), which may put the book beyond the reach of some who need it most.

T. S. PALMER.

WASHINGTON, D. C.

The Genera and Species of Blastoidea, with a list of the Specimens in the British Museum of Natural History. By F. A. BATHER. London. 1899. 8vo. Pp. x + 70.

This list "attempts to provide a complete index to every name that has ever been applied to a real or supposed Blastoid genus or species." It also gives the names now considered valid, and the synonyms with 'cross-references from the latter to the former.' It cites the literature, "the bibliographic details being placed under the name now valid. It catalogues all the specimens of Blastoidea contained in the Geological Department of the British Museum," and designates the specimens of historical interest, the types and figured specimens.

Bather's catalogue, like all of his work, is very detailed. The bibliographic references are not always mere title citations, but often give the important conclusions of writers, particularly those of synonymy. The list, however, 'is in no sense a revision' of the Blastoidea.

The important change in this list is the retention of *Nucleocrinus*, Conrad, 1842, in place of *Elæacrinus*, Roemer, 1851. *Orbitremites*, a nomen nudum of Gray, 1840, was established by T. & T. Austin, 1842, and, therefore, displaces *Granatocrinites*, Troost, 1849 (nom. nud.), *Granatocrinus*, Hall, 1862, and Etheridge and Carpenter, 1886. *Orophocrinus*, von Seebach, 1864, although in general use, should be displaced by *Dimorphicrinus*, d'Orbigny, 1849. Bather does not make this change, although he disapproves of Etheridge's and Carpenter's reason for rejecting this name, namely, *Dimorphicrinus*, "has never been adopted by paleontologists on account of the erroneous and incomplete nature of his generic diagnosis." On the same ground other names now in use can be rejected. The reviewer prefers to accept *Dimorphicrinus*.

The total number of specimens of Blastoidea in the British Museum is 1,223, representing 73 species out of a total of about 166 listed species. "These figures speak for themselves. However numerous may be the specimens of Blastoidea in other museums, there can scarcely be any collection so representative of the class as a whole, or so rich in specimens of the highest scientific importance, as in that of the British Museum."

CHARLES SCHUCHERT.

U. S. NATIONAL MUSEUM.

Grundlinien der Maritimen Meteorologie. Von PROFESSOR DR. W. KÖPPEN, Abtheilungs-Vorsteher an der Deutschen Seewarte. Hamburg, Verlag von G. W. Neumayer Nachfolger. 1899. 8vo. Pp. vi + 83.

There has for some time been need of just such a book as Dr. Köppen has now given us. We have a brief and elementary presentation of the fundamental principles of marine meteorology, arranged by a master of the subject, in attractive form. While the book is intended especially for seamen, and as an introduction to the more advanced *Segelhandbücher* of the German Naval Observatory at Hamburg, students of meteorology in general will find it admirably suited to their own use. There are six chapters, the subjects of which are as follows: I., instruments; II., the correlation of the weather elements; III., the periodic variations of temperature, pressure, etc.; IV., the geographic distribution of weather phenomena,

and the climates of the earth's surface; V., the difficulties in the way of navigation due to storms, head winds, calms and fog; VI., the movements of the ocean, viz., waves and tides. Of these chapters the fifth seems to us perhaps the most generally useful in the book. It deals with the nature, seasons, tracks and characteristics of cyclones in the different oceans, and the rules for navigating when in the vicinity of a cyclone. The relation of the prevailing winds and calm belts to various sailing routes are clearly presented, and the prevalence of fog in different regions is briefly discussed.

In connection with the sailing directions, Köppen makes use of an ingenious device, modelled after Piddington's famous transparent storm cards in his classic 'Sailors' Horn Book for the Law of Storms.' Köppen's storm card consists of a transparent sheet of paper, on which are three figures. The first shows the winds around a cyclone in the Northern Hemisphere; the second shows the winds around an anticyclone in the Northern Hemisphere; and the third shows the characteristic isobaric types and accompanying wind changes during the easterly movement of ordinary weather conditions. By turning the transparent paper over, the same diagrams serve for the Southern Hemisphere.

Such a book as Köppen's *Grundlinien der Maritimen Meteorologie* should be translated into English, and it is to be hoped that the author will arrange to have an English edition published shortly.

R. DeC. Ward.

Descriptive General Chemistry. By S. E. Tillman, Professor in the U. S. Military Academy. New York, John Wiley & Sons. 1899. 2d Ed., p. 429.

This new aspirant for chemical honors has been written mainly for the use of the cadets of the U. S. Military Academy. In the language of the author "it has generally been the conclusion of those charged with this instruction at the Academy in the past that the laboratory method alone, or mainly, in so short a course, could not be made of as much value to the pupils as the method of making the *acquisition of knowledge* the essential feature, and that the best results could be reached through careful study of the proper text, well-conducted recitations, accompanied by experimental and explanatory lectures." Accordingly "this book has been prepared to embody the substance and arrangement of a short chemical course for the *general* student. It aims to give a concise statement of the more fundamental principles of chemistry, together with that class of chemical information most essential to cultured men, and which will enable them to comprehend many ordinary natural phenomena, as well as to understand the more important applications of the science which are now so frequently met with. The book is not fitted nor intended for laboratory guidance."

It is an interesting production and merits high praise and a cordial reception from all interested in the promulgation of chemical science.

Edgar F. Smith.

Elementary Studies in Chemistry. By Joseph Torrey, Jr., Harvard University. New York, Henry Holt & Co. 1899. Pp. 487.

Nearly every teacher of chemistry in time feels that even the best text-books which have been prepared are not just exactly what he desires. He is imbued with the idea that what he wishes the student to derive from a course of chemical instruction can be better obtained by some other method or plan than any previously proposed. In other words, he wishes to reach the goal in his own peculiar way. He knows what that goal represents, how he reached it, and is firmly convinced that by his method those placed in his charge can also gain it. The usual result of this reasoning is eventually a new book on chemistry. The author of the present volume, 'dedicated to my students, past and present,' has doubtless had his own experience in getting young men to profit by careful drill in chemical experimentation, etc., and in this new contribution outlines his method of instruction.

The reviewer has had great pleasure in following the different steps of the development, and is happy to add that in his humble judgment, Mr. Torrey has prepared a most valuable student guide, and deserves the congratulations of both students and teachers of the science.

Edgar F. Smith.

BOOKS RECEIVED.

Einfuhrung in die Chemie in leichfassliche Form. LASSAR-COHN. Hamburg and Leipzig, Leopold Voss. 1899. Pp. xii + 299. M. 4.

Qualitative Analysis for Secondary Schools. CYRUS W. IRISH. New York, Cincinnati and Chicago, American Book Co. 1899. Pp. 99.

Laboratory Exercises, with Outlines for the Study of Chemistry. H. H. NICHOLSON and SAMUEL AVERY. New York, Henry Holt & Co. 1899. Pp. vi + 134. 60 cents.

The Hygiene of Transmissible Diseases. A. C. ABBOTT. Philadelphia, W. B. Saunders. 1899. Pp. 311.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for September opens with 'A Contribution to the Life History of Autodax lugubris Hallow,' by Wm. E. Ritter and Loye Miller, followed by an account of 'The Worcester Natural History Society,' by Herbert D. Braman. The third of the very useful 'Synopses of North American Invertebrates,' is by J. S. Kingsley and deals with the Caridea; and N. R. Harrington who this summer sacrificed his life in order to study Polypterus, contributes a valuable article on its life habits. The 'Pads on the Palm and Sole of the Human Fœtus' are discussed by R. H. Johnson who considers them homologous with the walking pads of some mammals. Among the topics discussed by the editor is that of 'New Species,' many of which are considered to be founded on very trivial characters.

DISCUSSION AND CORRESPONDENCE.

NATURALISM AND PHILOSOPHY.

"Had men in the discoveries of the natural world, done as they have in the intellectual world, involved all in the obscurity of doubtful and uncertain ways of talking, volumes writ of navigation and voyages, theories and stories of zones and tides, multiplied and disputed, nay, ships built and fleets sent out, would never have been taught us the way beyond the line, and the antipodes would still be as much unknown as when it was declared heresy to hold there were any."

IN a discussion, in the current number of SCIENCE of my criticism of Ward's *Naturalism and Agnosticism*, it is intimated that my 'harshness' may, perhaps, be due to irritation by Ward's castigation of Spencer. I therefore wish to say that I read this with interest and sympathy, and found it by far the most valuable part of the book; but as Ward's method of treating the Synthetic Philosophy is an old story to zoologists, I saw no reason to review it for readers of SCIENCE.

As I understand Ward's reasoning on this subject, I fully agree with it, and should myself put it in these words: It is not by generalization and abstraction, but by discovery, that knowledge is advanced; but the first principles of this philosophy are based upon abstraction and generalization and can add nothing to knowledge.

Zoologists have long been aware that they who, in past generations, sought to advance our knowledge of living things by generalizing them, or referring them to genera, hindered the progress of zoology, which began to advance with rapid strides as soon as naturalists perceived that our only source of knowledge of living things is the study of the living things themselves. So far as it concerns the zoologist, Ward's method of handling the works of the author of 'The Principles of Biology' is ancient history—a record of a fight that was fought out fifty years ago.

Passing, then, to another topic, I ask space for a few quotations which seem to have a bearing upon the assertion by my critic that Ward's book is 'wrought out in sympathy with scientific methods.'

Ward says, II., 44.—"Granted that we are only entitled to say that the dice actually do fall, when they are thrown from the box, not that they must fall; granted that we may only say that their after course *is* entirely and absolutely the result of the initial conditions, not that it must be; still this is enough. * * * On the naturalistic assumption * * * matter and energy are indestructible and ingenerable, and the laws of their working rigorous, exact and unalterable."

It is not the naturalist, but the philosopher, who asserts that the dice *will* fall. The naturalist expects them to fall, but expectation, however well founded and reasonable, is not fatalism. Naturalism knows nothing of determinism. It does not assert that the after course of the

dice *is inevitably and absolutely the result of the initial conditions.* This is the teaching of philosophers. What the naturalist asserts is that the 'initial conditions' are signs which mean that he may expect the dice fall. So far as his scanty and imperfect knowledge of nature extends, all dice thus placed have thus fallen, and he has reasonable confidence—confidence so reasonable in this case that we call it moral certainty—that dice will continue so to do, since the after course of all the dice he has thrown has been neither more nor less than what the initial conditions would have led one to expect.

Ward says that he has tried, in his first lecture, to present "an outline sketch of that polity of many mansions, which we may call the Kingdom of the Sciences, and the mental atmosphere in which its citizens live"; but the mental atmosphere which is here presented is one in which few of these citizens would care to pass their lives, however wholesome the philosophers may find it.

Thus we are told, P. 13—"as to material phenomena, certain mechanical laws are held to be supreme; that a single atom should deviate from its predetermined course were as much a miracle as if Jupiter should break away from its orbit and set the whole system in commotion."

So far as I understand the mental atmosphere of the men of science, and may be permitted to speak for them, they assert that nothing can deviate from natural law, since nature is neither more nor less than that which is.

Scientific law involves no notion of supremacy, since it is nothing more than a statement of observed facts, joined to reasonable confidence—confidence which is more or less reasonable according to knowledge—what we may expect under certain conditions. As Berkeley has expressed it, natural laws are "general rules, which teach us how to act and what to expect."

To Ward's question, II., 85.—How we "know that the whole sidereal system will not turn out more like the bird than the stone; an organized whole manifesting life and self-direction?" he answers that he does not know anything of the sort. If Jupiter should *break away* from his orbit, and *set* the whole system in commotion, the true naturalist would assert, not with regret or disappointment, but with hearty satisfaction, that he knows more about celestial mechanics than he did before, and that he will now, if he has opportunity, study Jupiter's motives and his cerebral pathology, and try to find out what to expect from a planet so erratic. It is not he, but the philosophers, who teach that events which are mechanical are predetermined, although he does assert that he fails to see what good can come from an attempt to find out Jupiter's motives until he does begin to break things and to behave in a way which astronomers had no reason to expect.

Ward tells, II., 48.—that as the naturalists conceive the world as a whole "it seems comparable to nothing so much as an upturned hour glass. The glass could not start itself; this, at least, was an interference from without, but it was an interference before the process, not during it. Science, which is confined to describing the movements of the sand, can give no account of this catastrophe, and no meaning to it. But once the glass is turned the downward dance of the last grain to move is just as inevitable as that of the first; and the several movements being fixed, any collateral consequences of them must be taken as fixed, too."

The naturalist does *not* know that the 'downward dance' of the first grain to move is inevitable. He asserts that he has good reason to expect and no reason to doubt that the sand will run. If it should do anything else, in the absence of an obstruction, he would know more than he does now, and he would try to find out why his expectations have disappointed him.

He asserts, furthermore, that he may find meaning in the turning of the glass, provided he knows what Ward himself calls the 'initial conditions'; that he has good reason to believe that some one turned it because he chose.

He also has good reason to believe that, if he had known these initial conditions, the desire to turn the glass, and the turning of the glass, would be neither less nor more than he might have expected.

The interminable controversy about deter-

minism and free will does not exist for the naturalist—not because he doubts his freedom and responsibility, but because he knows nothing of determinism.

We cannot be surprised that some students of science should confuse their reasonable expectations that the future will, on the whole, be essentially like the past with belief that it must so be, when we remember how often they have been told by philosophers like Ward that the scientific conception of the mechanism of nature is the conception of 'an unbroken and unbreakable mechanism,' which 'absolutely determines' the order of events, and 'banishes spirit and spontaneity,' 'holding all things fast in fate'; although most men of science are now as emphatic as Berkeley in the declaration that naturalism means nothing of the sort. What they assert that it does mean is that we know nothing of 'catastrophes.' As Sir Thomas Browne tells us: "It was the ignorance of man's nature that begat this very name, and by a careless term miscalled the providence of God; for there is no liberty for causes to operate in a loose or careless way."

W. K. Brooks.

Johns Hopkins University.

MEDICAL SCIENCES IN THE UNIVERSITY.

To the Editor of Science.—Permit me to call attention to a somewhat inaccurate statement made by Professor Minot in his very interesting address delivered at the Medical Commencement of Yale University and subsequently published in Science. Professor Minot says: "If a young man wishes to make a scientific career, if his interest is chemistry, physics, botany or zoology, he is received at one of our universities started upon a well-planned course properly systematized, he gives for two or three years most of his strength to his main subject, but he follows probably two cognate subjects as minor studies, and at the end of his time, if successful in his work, he receives a degree, which attests his proficiency in his special science. Should the same young man elect to study one of the medical sciences, physiology, pathology or bacteriology, no university will give him corresponding recognition. The utmost he can find is opportunity for advanced work in his special subject, but with no university guidance, no plan of correlated studies, and he can look forward to no degree, nor even to a certificate from the university."

In this University, from its foundation in 1876, physiology has been given complete university standing. Its courses are coördinate in every way with those in chemistry, physics, botany or zoölogy, and many students have offered it, after three or more years of continuous study, as a major subject for the degree of Doctor of Philosophy. The same may be said with regard to pathology and bacteriology.

I speak only for the Johns Hopkins University, but there are other universities in this country in which physiology is also accorded every privilege in the philosophical faculty.

W. H. Howell.

Johns Hopkins University, Baltimore, Md.
September 28, 1899.

NOTES ON INORGANIC CHEMISTRY.

Owing to the difficulties in the way of using acetylene on a large scale as an illuminant, and in part perhaps also owing to the opposition raised by those interested in other methods of lighting, the new illuminant has not made the rapid progress predicted for it. Some towns on the continent of Europe, however, have adopted it, as the town of Veszprim in Hungary, and in a recent number of the *Chemiker Zeitung*, Professor J. Vértess gives a paper on some of the drawbacks which attend the use of acetylene. In the first place the calcium carbid from which it is generated is in commerce never pure, but contains at least 20 per cent. of impurities. Theoretically, 350 liters acetylene per kilo carbid should be obtained, but as a matter of fact in practice hardly more than 280 or 290 liters can be depended upon. Again, the carbid contains sulfur, phosphorus and nitrogen, so that we have as impurities in the acetylene, hydrogen sulfid, phosphin and ammonia; hence it follows that acetylene must be purified in much the same way as ordinary coal gas. While burning from an ordinary burner, after a time the flame becomes smoky and carbon is deposited on the burners. This seems to be owing to the burner attaining a temperature higher than that of the decomposition of acetylene. Vértess also

calls attention to another drawback, in occasional fog formed in a closed room where acetylene is used. This he thinks is due to the deposition of carbon as the hydrogen of the acetylene burns, thus creating a sort of mist. It will require some ingenuity to overcome all these difficulties, but we cannot doubt but that it will be accomplished in the near future; as it is, the progress of acetylene has advanced much more rapidly than any other form of artificial illumination.

The most serious problem in the generation of acetylene on a small scale is the after-formation of gas in the generator. This is discussed by P. Wolff in the *Metallarbeiter*, and reproduced in the *Chemical News*. According to Wolff this after-generation is due to three causes: the action of the residual water contained in the pores of the carbid, the condensation of water on the surface of the carbid, and the absorption of aqueous vapor. In an experiment where the carbid reservoir was over petroleum, the after-generation was 6 liters in 24 hours, 16 liters in three days and remained constant at this figure. Over water 25 liters were given off in one day, and 30 liters in three days. The generation of gas continued at five to six liters a day until the carbid in the generator was completely decomposed. This shows the danger in small generators where there can be no large reservoir. In large apparatus a gas reservoir can be attached which will have capacity to hold this generated gas and that without compression, which would render it dangerous. The best device is spoken of as being that of Münsterberg, which not only has a relatively large reservoir, but a device for closing the carbid chamber by an air-tight valve which completely shuts off the chamber when the apparatus is not in use. No mention is made of the device which has been used in this country, where the carbid is dropped in small lumps into water. As each piece is exhausted a new portion is fed automatically.

Professor R. Stavenhagen, of Berlin, has described in the *Berichte* the properties of tungsten, which have been, heretofore, only imperfectly studied in impure specimens of the metal. The tungsten was obtained by reduction of the oxide by aluminum. It is found to be practically insoluble in acids, even in aqua regia; it dissolves slowly, however, in fused caustic potash. It is decidedly hard, of a color slightly darker than that of zinc, and is infusible in the electric arc.

According to the *Chemical News* of August 18th, Professor Dewar, at the Royal Institution, had just succeeded in obtaining hydrogen as a solid, glassy, transparent mass. Further particulars of this interesting discovery will be eagerly looked forward to.

J. L. H.

THE NEW COLLEGE PRESIDENTS.

On this subject the *Educational Review* for September comments editorially as follows:

"Four of the most important college presidencies to which we made reference some time ago have been filled, and so satisfactorily filled that it is a matter for rejoicing. It seems to us that Presidents Hadley of Yale, Harris of Amherst, Faunce of Brown, and Wheeler of California were the best selections possible, taking into account the peculiar traditions and problems of each of the four institutions and the personal equation of the man chosen to preside, we hope for at least a quarter of a century, over the teaching body of each. Three of the four men are successful and experienced teachers, and the fourth is a clergyman whose teaching instinct is very strong and whose relations to education have been very close. In these elections the recently exploited newspaper theory that a large college needs a business man or a money getter for President has received a set-back and a severe rebuke. We can imagine few things worse for higher education in the United States than to have the spirit of commercial trading and the business man's point of view obtain strong foothold in it. 'Business methods' have debauched and are debauching politics on every hand, and the treasure house of education must be protected from their inroads at all hazards. The idealism which American life so sorely needs must be furnished in large part by the universities, and the two last questions for their governing boards to be taught to ask are, Is it 'timely'? and, Will it pay?

"Moreover, the typical business man cannot, in the nature of the case, be successful in such a post. His standards of success are the reverse of educational. Underneath the temporary appearance of external prosperity which such a president might bring, there is almost certain to be the dry rot of educational neglect. The more important the college or university, the more surely it needs expert educational supervision. For this there is no possible substitute. Like a city school system, a college or university needs someone in its administration who knows and understands its educational activity in every part, who can distinguish real teaching from sham teaching, and the force of whose personal inspiration will be felt in every department. Those who remember the administration of President McCosh of Princeton, well understand what this means.

"The four new presidents are men of this type. They are men of strong personality, and each will leave his mark for good upon the institution which has honored him. All four are, in a large sense, men of affairs, and may be expected to relate their institutions more closely than ever to the life and thought of the time. This new impulse is particularly needed at Yale, where what we believe to be an unfortunate and dangerous policy of educational isolation has long been pursued. To overcome that isolation, and to restore Yale to its legitimate place as a progressive educational influence are likely to be two of the most noteworthy achievements of President Hadley's administration."

THE PROTECTION OF BIRDS.

THE Commissioner of Education, of the Public Schools, of the State of Rhode Island, Thos. B. Stockwell, has issued the following circular:

TO THE SCHOOL OFFICERS AND TEACHERS OF THE STATE OF RHODE ISLAND:

I desire to call your attention to the efforts now being made in this State by the Audubon Society for the preservation of our native birds. From reliable statistics it is evident that unless some active measures are speedily taken, their number will be very much reduced and some varieties will become extinct.

The value of the birds, from various points of view, is incalculable. As a protection to the farmer against the ravages of countless forms of insect life, as a source of joy and satisfaction to every lover of nature, they minister both to our material and our æsthetic interest. Indeed, it was not till within a few years that the Department of Agriculture, through a long course of accurate observations, determined beyond a question the economic value of almost every native bird in his relation to the various forms of vegetation; and it is no longer debatable whether the inroads of certain pests destructive to certain forms of vegetation are not due quite largely to the scarcity of the birds.

As any improvement in this matter must be brought by imparting more correct information about the birds, it is evident that the public schools, and especially those of the country sections, afford the most effective means for the dissemination of the facts, and the awakening of a life interest in the protection of bird life. The new movement towards Nature Study, which has recently been manifested and is spreading quite rapidly through the schools, furnishes the natural channel by means of which instruction and information on this subject may be readily brought before the children, and through them to the people generally.

The more our children are brought into the right touch with nature, and especially with such beautiful creatures as the birds, the more certain it is that their minds and hearts will be filled with right sentiments and feelings, and that their characters will be moulded aright.

To that end then I bespeak your cordial interest in this general subject, and your coöperation with the plans of the Audobon Society for the protection of our feathered friends.

THE COMPANIONS OF POLARIS.

PROFESSOR W. W. CAMPBELL, of Lick Observatory has made the following statement in regard to his discovery that Polaris or the North Star is a triple system:

The observations of Polaris were made with the Mill's spectroscope attached to the thirty-six-inch telescope. From the well-known principle of the shifting of the lines in the spectrum of a star, we can determine whether the star is approaching or receding from the observers and how rapidly. For most stars the velocity is constant. For some stars the velocity is variable, due to the attractions of companion stars.

The recent observations of Polaris at Lick Observatory show that its velocity is variable. It is approaching the solar system now with a

velocity of eight kilometers per second. This will increase in two days to fourteen kilometers, and in the next two days will decrease again to eight kilometers. This cycle of change is repeated every four days. The bright Polaris, therefore, revolves about the centre of gravity of itself and its invisible companion once in four days. The orbit is nearly circular and is comparable in size with the moon's orbit around the earth.

This centre of gravity, and therefore the binary system, is approaching the solar system at present with a velocity of eleven and a half kilometers per second. A few measures of the velocity of Polaris made here in 1896 gave its approach at the rate of twenty kilometers per second. Part of this change since 1896 could be due to a change in position of the orbits of the binary system, but most of it must have been produced by the attraction of a third body on the two bodies comprising the four-day system. The period of revolution of the binary system around the centre of gravity of itself and the third body is not known, but is probably many years.

Both companions of Polaris are invisible, but their presence is proved by disturbances which their attractions produce in the motion of the bright Polaris.

SCIENTIFIC NOTES AND NEWS.

The British Association for the Advancement of Science has held a successful meeting at Dover. We publish this week the address of the president, Sir Michael Foster, and hope to be able to publish shortly some account of the meeting and several of the addresses given by the presidents of the sections.

The International Geographical Congress began its meeting at Berlin on September 27th, with about 1200 members in attendance. Baron von Richthofen presided, Prince von Hohenlohe, the imperial Chancellor being the honorary president. The sections were as follows: (1) mathematical geography, geodesy, cartography, geophysics; (2) physical geography (geomorphology, oceanology, climatology); (3) biological geography; (4) industrial and commercial geography; (5) ethnology; (6) topical geography, exploring travels; (7) history of geography and of cartography; (8) methodology' school geography, bibliography, orthography of geographical names. Among the Americans in attendance were General A. W. Greely, of the U. S. Signal Service, Professor W. M. Davis, of Harvard University, and Mr. A. L. Rotch of the Blue Hill Observatory.

It has been decided that the Zoological Park of New York will be opened to the public either on October 18th or October 25th.

The commission from the Johns Hopkins University, under the direction of Dr. Simon Flexner, has returned from Manila where the summer has been spent in the study of tropical diseases.

Mr. Walter Wellman arrived in London on August 28th and gave at the British Association an account of his Polar expedition. He sailed for New York on September 30th.

The freedom of the borough of Carnarvon was conferred upon Sir W. H. Preece, the eminent engineer, on September 21st. He was also presented by the Town Council with a silver casket and entertained at a banquet.

Dr. Anton Fritsch, director of the zoological and paleontological collections of the museum at Prag, has published in a local paper an account of his recent visit to America. He speaks in high praise of the museums, institutions and collections, and recommends younger men of science to follow his example and visit the scientific institutions of the United States.

Dr. George A. Hendricks, professor of anatomy in the College of Medicine and Surgery of the University of Minnesota, died in Minneapolis on September 24th.

Signor Marconi has been able to report successfully by wireless telegraphy the international yacht races. The messages were sent from the steamship *Ponce* to a station at Navesink Highlands.

A telegram has been received at the Harvard College Observatory from Professor Krentz at Kiel Observatory, stating that a comet was discovered by Gacobini at Nice, Sept. 29, 313 Greenwich Mean Time, in R. A. $16^h\ 26^m\ 32^s$ and Dec. $-\ 5°\ 10'$.

Daily motion in R. A. $+\ 2^m\ 0^s$
Daily motion in Dec. $+\ 0°\ 10'$.

WE learn from the *Botanical Gazette* that Dr. Henry C. Cowles of the University of Chicago has spent several weeks with a party of advanced students at Marquette, Mich., prosecuting ecological studies on the adjacent flora.

THE executors of the late Professor O. C. Marsh, of Yale University, will sell for the benefit of the University his valuable collection of orchids, objects of art, antiques, etc. The sale will take place during the present month but the exact date is not yet fixed.

THE first meeting of the International Congress of Life Assurance will be held in Brussels from September 25th to the 28th.

THE American Institute of Mining Engineers held last week its annual meeting in San Francisco. At the adjournment a two weeks' visit through the mining regions of the State was begun.

THE tenth annual general meeting of the British Institution of Mining Engineers met at University College, Sheffield, on September 19th, with Mr. C. H. Peak, of Walsall, presiding. It was reported that the number of members is now 2,075, a slight decrease compared with last year.

AT the annual meeting of the American Otological Society, Dr. Blake presented a resolution asking for coöperation with the National Association of Teachers of the Deaf and Dumb, to secure systematic examination of the pupils in deaf-mute schools throughout the United States, explaining the necessity of thorough and qualified investigation in order to select those pupils who could be most benefited by special teaching, or who perhaps by some treatment could be made better able to accept teaching.

THE Chambers of Commerce that met recently at Belfast, Ireland, urged upon the British Government the necessity of making the metric system compulsory. It was pointed out from consular reports, that much loss of trade has resulted in South America and elsewhere from Great Britain's adherence to the antiquated system.

MR. H. M. WHELPLEY, of St. Louis, has been collecting statistics in regard to the use of the metric system in physicians' prescriptions. It appears that of 1,008,500 prescriptions that have been examined, 6 per cent. were in the metric system. Reports were received from apothecaries in forty-two States and Territories. *The Pharmaceutical Era* from which we take this information earnestly advocates the metric system in medical prescriptions. It states that the system is taught in all pharmaceutical colleges but only in very few medical colleges.

THE city of Ithaca, N. Y., at the meeting of its Common Council, September 20th, followed the example of some of the largest cities of the State, including Buffalo, Rochester, Utica and Binghamton, and adopted voting machines. The contract guarantees their reliability and accuracy, is accompanied by a bond, not only for fulfillment of the contract in other respects, but also in the matter of possible patent litigation, makes the compensation payable out of the savings effected by use of the machines costing the city, in fact, nothing; while, in the end, not only providing what is claimed to be absolute insurance that no man shall lose his vote by defective or spoiled ballot, but also yearly profit by the change which, if capitalized at the city's rate of credit, 4 per cent., would amount to about one-half the city budget as fixed by its charter.

ADVICE has been received at Liverpool from the Malarial Investigation Expedition in West Africa, that the members of the Liverpool Commission, with the assistance of the colonial medical staff and others, have now started the operation of hunting for the anopholes (malarial mosquito) grub in water. This is a tedious but most important task, and necessitates a very careful inspection of all the ground in Freetown. So far these grubs have only been found in a shallow puddle and two tubs of stagnant water, but it is hoped that the minute inspection of the ground that is now being conducted will have satisfactory results. Dr. van Neck, the official delegate of the Belgian Government, who started from Antwerp after the English members had sailed, has now joined the expedition. In view of the importance of completing the expedition's researches, instructions have been cabled to Major Ross to use his own discretion as regards the date of his return. It is hoped that this

extension of time will enable the commission to complete its labors satisfactorily. The Secretary of State, of the Treasury of the United States, has written stating that he regrets that the invitation to send an American delegate was not received in time for the detail of an officer of the Marine Service Hospital to accompany the expedition.

A CORRESPONDENT of *Industries and Iron* of London, for whom its editor vouches as a competent judge, gives the following hindrances to introduction of the Nernst lamp: (1) There is no automatic heating arrangement to the small power lamps, and they each require about eight seconds in artificial heating to be brought to incandescence; (2) No small lamps of small candle power have yet been produced; (3) There are three wires to each, and the lamps cannot therefore be connected without inconvenience to existing standards; (4) Excepting mere laboratory tests there is no *practical* experience of the life of the lamp; (5) It has never yet been attempted to manufacture the lamp on a commercial scale, and not one lamp on the Nernst principle is yet in commercial use; (6) More than one firm of eminence have adopted the opinion that the principle of the lamp has been anticipated by the Jablochkoff candle, thus impeaching the validity of the Nernst patent.

UNIVERSITY AND EDUCATIONAL NEWS.

WE are glad to be able to give a correct account of Mrs. Hearst's plans for the University of California. Mrs. Hearst has not made any official announcement, and is not likely to do so, because she intends to superintend the use of her gifts herself. But the following may be considered as certain: She has by *will* devoted her fortune to the University—this in case of her death. But she intends to give during her lifetime all or the greater part, and from time to time as necessary to carry out her plans. She intends to commence next spring to put up two buildings, one of which is to be the mining building. It is not certain what the other will be. Besides there are good grounds for the belief that other wealthy residents of California, incited by Mrs. Hearst's example, will next year put up three other buildings. Mrs. Hearst has determined to live in Berkeley in order to be in closer touch with the University. It is expected that M. Bénard, the architect, will go to Berkeley to superintend the work. Negotiations to that effect are going on. Finally, it may be stated that Mrs. Hearst understands perfectly well that buildings require a corresponding endowment.

CORNELL UNIVERSITY opens with an entering class membership above 600. Sibley College has a freshman class of about 200 and many new men in the upper classes and graduate departments.

THE third course in advanced agricultural chemistry, in the School of Graduate Studies, of the Columbian University, Washington, D. C., will begin September 27th, under the direction of Dr. H. H Wiley. Graduates of agricultural colleges and other institutions of good standing, are eligible for admission to this course. Under certain restrictions graduates are admitted to the chemical laboratory of the department of agriculture. Advanced courses in soil studies, agricultural technical chemistry and in the study of food will be begun at once with laboratory practice. This school offers special advantages to the graduates of agricultural colleges who wish to complete their advanced studies in agricultural sciences.

A CHAIR of the theory, art and practice of education has been established in Owen's College, Manchester, and Mr. H. L. Withers, now principal of the training college at Isleworth, has been called to be the first incumbent.

DR. C. B. DAVENPORT, of Harvard University, has been called to the zoological department of the University of Chicago to fill the place left vacant by the removal of Professor Wheeler to the University of Texas.

W. D. MERRILL, PH.D. (Chicago), has been appointed instructor in biology, with special reference to botany, in the University of Rochester.

DR. CHARLES G. SHAW has been appointed to the position in the department of philosophy in New York University made vacant by the resignation of Dr. J. H. McCracken, to accept the Presidency of Westminster College, at Fulton, Mo.

SCIENCE

Friday, October 13, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE DOVER MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

It appears from the accounts in the foreign journals and from communications sent us that the recent meeting of the Association maintained the standard set by its long history. The address by the President already published in this Journal, was a model of what such an address should be, and the addresses of the presidents of the Sections were thoroughly scientific and yet, at the same time, intelligible to all. We give below some account of the more important papers presented before the different sections.

The special event of the meeting was the interchange of visits between the members of the British and French Associations. About 280 members of the French Association came over from Bologne on the Saturday of the meeting, and were entertained both socially and by placing on the programs several addresses and papers of special interest. On the following Wednesday about 100 members of the French Association again crossed the Channel and met members of the British Association at Canterbury. The visits were returned on Thursday by about 250 members of the British Association. On these different oc-

* Based on reports in the London *Times* and in *Nature.*

casions there were numerous addresses and expressions of good-will.

There was in all an attendance of 1,403 at the Dover meeting, but when it is remembered that more than half were associates and new annual members, it will be seen that the meeting was no larger than those of the American Association, when held at places equally accessible to as many members. The British Association, however, greatly exceeds our own in its ability to make grants for scientific research. In addition to a special appropriation of £1,000 for the British Antarctic expedition, grants amounting to £1,115 were made as follows:

Mathematics.	£
Rayleigh, Lord—Electrical Standards (£300 in hand)	25
Judd, Prof. J. W.—Seismological Observations (£9 5s. 4d. in hand)	60
FitzGerald, Prof. G. F.—Radiation in a Magnetic Field	25
Rücker, Prof. A. W.—Magnetic Force on board Ship	10
Callendar, Prof. H. L.—Meteorological Observatory, Montreal	20
Kelvin, Lord—Tables of Mathematical Functions	75
Chemistry.	
Hartley, Prof. W. N.—Relation between Absorption Spectra and Constitution of Organic Bodies	30
Roscoe, Sir H. E.—Wave-length Tables	5
Reynolds, Prof. J. E.—Electrolytic Quantitative Analysis	5
Miers, Prof. H. A.—Isomorphous Sulphonic Derivatives of Benzene	20
Neville, Mr. F. H.—The Nature of Alloys	30
Geology.	
Hull, Prof. E.—Erratic Blocks (£6 in hand)	
Geikie, Prof. J.—Photographs of Geological Interest	10
Dawkins, Prof. W. B.—Remains of Elk in the Isle of Man	5
Dawson, Sir J. W.—Pleistocene Fauna and Flora in Canada	10
Lloyd-Morgan, Prof. C.—Ossiferous Caves at Uphill (£8 in hand)	10
Watts, Prof. W. W.—Movements of Underground Waters of Craven	40
Scharff, Dr.—Exploration of Irish Caves	20
Zoology.	
Herdman, Prof. W. A.—Table at the Zoological Station, Naples	100
Bourne, Mr. G. C.—Table at the Biological Laboratory, Plymouth	20
Woodward, Dr. H.—Index Generum et Specierum Animalium	50
Newton, Prof.—Migration of Birds	15
Lankester, Prof. E. Ray.—Plankton and Physical Conditions of the English Channel	40
Newton, Prof.—Zoology of the Sandwich Islands	100
Sedgwick, Mr. A.—Coral Reefs of the Indian Region	30
Geography.	
Murray, Sir John—Physical and Chemical Constants of Sea Water	100
Economic Science and Statistics.	
Price, Mr. L. L.—Future Dealings in Raw Produce	5
Sedgwick, Prof. H.—State Monopolies in other Countries (£13 13s. 6d. in hand)	
Mechanical Science.	
Preece, Sir W. H.—Small Screw Gauge (£17 1s. 2d. in hand)	
Anthropology.	
Evans, Mr. A. J.—Silchester Excavation	10
Penhallow, Prof. D. P.—Ethnological Survey of Canada	50
Tylor, Prof. E. B.—New Edition of 'Anthropological Notes and Queries'	40
Garson, Dr. J. G.—Age of Stone Circles (balance in hand)	
Read, Mr. C. H.—Photographs of Anthropological Interest	10
Brabrook, Mr. E. W.—Mental and Physical Condition of Children	5
Read, Mr. C. H.—Ethnography of the Malay Peninsula	25
Physiology.	
Schäfer, Prof. E. A.—Physiological Effects of Peptone	20
Schäfer, Prof. E. A.—Comparative Histology of Suprarenal Capsules	20
Gotch, Prof. F.—Comparative Histology of Cerebral Cortex	5
Gotch, Prof. F.—Electrical Changes in Mammalian Nerves	20
Starling, Dr.—Vascular Supply of Secreting Glands	10
Botany.	
Darwin, Mr. F.—Assimilation in Plants (£6 6s. 8d. in hand)	

Farmer, Prof. J. B.—Fertilization in Phæophyceæ 20

Corresponding Societies.

Meldola, Prof. R.—Preparation of Report.......... 20

The report of the Council adopted by the general committee, made a number of important reports and recommendations. Arrangements have been made for the establishment of a Bureau of Ethnology in coöperation with the British Museum. The Government of Cape Colony is not able to make immediate provision for a magnetic observatory. Plans are being arranged for a central building for seismological observations and to collect statistics of the physical and mental characteristics of the races throughout the Empire, especially in India. It was decided not to reprint the collected reports on the Northwestern Tribes of Canada in a single volume. The British Admiralty was requested to secure systematic observations on the erosion of the sea coast.

We hope to be able to publish special accounts of the proceedings of some of the sections, but it may be convenient for the reader to have a general survey of the more important papers presented during the meeting. In the Mathematica land Physical Section the interest created by the address of the president, Professor Poynting, already published in Science, was sustained throughout the meeting by papers describing the results of important work. The much-discussed question of color-vision was raised once more by the paper of Mr. G. J. Burch on 'The Spectroscopical Examination of Contrast Phenomena.' His investigations lead him to support the Helmholtz theory, but also to suppose that a fourth primary sensation should be admitted—namely, blue. During the year the committee on electrolysis and electrochemistry continued the work begun last year and furnished a report of progress.

On the occasion of the visit of members of the French Association, Professor J. J. Thomson gave a masterly exposition of the various lines of research by which it has been concluded that the atom is not the smallest existing quantity of matter. Electro-chemical phenomena teach us to associate a definite amount of electricity with each atom of matter; but these recent researches indicate that under certain circumstances a much larger quantity of negative electricity may be conveyed by the atom, or else that the negative electrical charge resides on a small detachable portion of the 'atom,' which alone is concerned in the experiments. The positive charge seems to be distributed over the whole mass of the atom.

The exploration of the higher regions of our atmosphere, by means of kites bearing meteorological instruments, was reported by Mr. A. L. Rotch, of the Blue Hill Observatory, and supplied convincing proof of its usefulness in weather forecasting and in climatology. Professor Darwin called attention to the fact that such work is unduly negelcted in Great Britain, because there is no Government meteorological observatory. Another interesting paper from America was presented by Dr. L. A. Bauer, who described the work of the newly-organized division of the U. S. Coast and Geodetic Survey for the study of terrestrial magnetism in the United States. A discussion on thermometry which was introduced by Professor Callendar, will, it is hoped, lead to the adoption of a standard platinum thermometer. The matter is to be fully discussed by the Committee on Electric Standards, which has done good work in the past in connection with electrical measurement.

In the Chemical Section particular prominence was given to the discussion of subjects of a general character. Undoubted good resulted from the consideration of the best means to organize the study of atomic weight determinations, whilst the joint dis-

cussion with Section K (Botany) on symbiotic fermentation, in which several of the French visitors took part, was of much interest. Professor Marshall Ward, in opening the discussion, after considering the conditions under which symbiosis existed both in the vegetable and animal kingdoms, illustrating his views with such examples as that of the dual organism of lichens in which alga and fungus were the contributory organisms, passed to the more special subject of symbiotic fermentation. In symbiotic fermentations the one organism, such as a mould, appeared to prepare the way for the action of a subsequent agent, such as yeast; and the preparation of Japanese saké, or rice wine, is a typical example of this dual effect. The discussion which followed it is hoped has led to a more exact recognition of the divisions and relations of symbiotic changes which may serve to develop the study of the subject.

Professor Dewar's important discoveries relating to the solidification of hydrogen will be noticed subsequently. Colonel Waterhouse contributed a note on a remarkable result he has observed on the exposure of metallic silver to light; a visible image results on the exposed plate after prolonged exposure, but the effect may be got in a very much shorter space of time by the development of the latent image that is produced. The industrial application of what was probably a similar action was referred to by Sir W. Roberts-Austen. Although the papers on organic chemistry were of a technical character, the discussions, reports, and individual contributions in this branch of the science aroused much interest, and special importance is to be attached to a paper by Mr. W. J. Pope, on the influence of solvents upon the optical activity of organic compounds.

The chemists present at Dover will always look back upon the meeting with a special appreciation of the able address delivered by the President of the Section, Dr. Horace T. Brown. The subject of the fixation of carbon by plants is a common meeting ground for the chemist, physicist and biologist. After reference to the accustomed view that the higher plants derive the whole of the carbon which goes to build up their tissues from the carbonic acid of the atmosphere, Dr. Brown reviewed the work that has been done to show that extra-atmospheric sources of carbon may exist, and detailed his own experiments on the intake of carbon dioxide by plants, showing that this is directly proportional to the tension of the gas.

Sir Archibald Geike's presidential address before the Section of Geology which was given on the occasion of the visit of the French Association is printed below. The list of papers in geology was, as usual, a full one, so that, especially during the earlier days of the meeting, the time for discussion was limited. The subjects dealt with ranged over the whole of the wide field included in geological science, without any particular division being notably prominent. In stratigraphical as well as in economic geology the most important papers were those dealing with the coalfields, and from their additional local interest those of Mr. R. Etheridge, F.R.S., and Professor W. Boyd Dawkins, attracted especial attention. Mr. Etheridge treated the relations existing between the Franco-Belgian coalfield and those of Southwestern Britain, with the object of proving that the recent discoveries in Kent indicated the existence of a chain of concealed coal-basins connecting the two regions. Professor Boyd Dawkins, while pursuing the same general argument and recapitulating the history of the discoveries in Kent, gave a brief description of the borings at present in progress under his superintendence at Ropersole, Ottinge, Hothfield, Old Soar, near Tonbridge, and Penshurst. At pres-

ent only the first of these has penetrated the secondary rocks, reaching coal measures at a depth of 1,580 feet below the surface; the others have reached various horizons in the lower Cretaceous and Jurassic strata, which are found to thicken rapidly southward. Professor Boyd Dawkins concluded from the evidence of these borings that the southern boundary of the concealed coalfield in the eastern part of its course ranges nearly under the scarp of the South Downs, and that to the south of this the paleozoic floor is probably composed of rocks older than the coal measures.

The concealed coal fields of another part of England—viz., North Staffordshire—were discussed by Mr. Walcot Gibson, of the Geological Survey, whose recent investigations have shown that the so-called Permian rocks which overlie the productive measures at the margin of this field should be considered as part of the carboniferous system, since they are conformable to the upper coal-measures and contain a coal-measure flora. By working out the details of these rocks, Mr. Gibson has been able to show that on the northwestern side of the Staffordshire anticline the productive coal-measures are likely to occur within reach further west than might have been expected, thus increasing considerably the workable area of this coal field. It is interesting to find that these results have been attained by the minute study of strata which in themselves do not possess any direct economic value. Another stratigraphical paper with a practical application was that of Professor Boyd Dawkins on the geological conditions of the proposed channel tunnel. The reading of this paper was followed by a brisk discussion, in which it was generally acknowledged that, apart from political reasons, there was not likely to be any serious difficulty in driving the tunnel through the lower beds of the chalk from England to France. In the division of structural geology, Mrs. M. M. Gordon, D.Sc., contributed an analysis of the principles which underlie the complicated phenomena of folding to be found in the mountainous regions of the earth's crust.

As befitted the place of meeting, coast erosion received much attention from the section, three papers on this subject being read. Of these the most valuable was that of Mr. W. Whitaker, F.R.S., who summarized a large number of reports made by the coastguards all around the Kingdom as the result of circulars of inquiry sent out by the council of the Association with the sanction of the government authorities. This research promises eventually to yield highly important results in regard to the rate of destruction of our coasts by marine erosion.

In the department of paleontology, with the exception of one or two reports of committees, the papers were unimportant, while petrological science was represented mainly by a highly suggestive contribution by Professor A. Renard, of Ghent, on chondritic meteorites, in which it was pointed out that the rock structure of these visitants to our planet indicated that the parent mass had been subjected to the action of metamorphism in a manner similar to that of some of the rocks of the earth's crust.

A paper brought forward by Professor P. F. Kendall gave the result of some recent researches into the course of underground streams in the limestone district of Northwest Yorkshire; by the methods adopted the underground course taken by the principal sources of the river Aire have been more or less definitely traced.

The address of the President of Section D (Mr. Adam Sedgwick, F.R. S.) reviewed the facts of variation in their relation to reproduction and sex. Mr. Sedgwick contended that the variability of organisms must have been progressively greater the further we go back from the present time—

a conclusion of importance, because it enables the biologist to bring his requirements as to the time of evolutionary change within the limits granted by the physicist.

The memorable features of the Dover meeting, so far as the zoological communications were concerned, were undoubtedly Mr. J. J. Lister's account of the newly-discovered calcareous sponge *Astrosclera* and Mr. Smith Woodward's exhibition of fossil and recent remains of animals from Patagonia. The sponge, whose structure was explained by Mr. Lister, was exhibited at the International Zoological Congress at Cambridge last year, and completely puzzled all who examined it. It was brought home by Dr. Willey, along with other material, from the Loyalty Islands in the Western Pacific. During the past year Mr. Lister has subjected the four specimens to a minute and thorough examination. He finds their structure to be undoubtedly that of a calcareous sponge, differing, however, in regard to its skeleton, canal system, and other points from all other sponges extant, but resembling to a surprising extent the fossil group of *Pharetrones*, which are found in strata ranging from the Devonian to the chalk.

Mr. Smith Woodward's exhibition, on behalf of Dr. Moreno, of some newly-discovered remains of the ground-sloth *Neomylodon*, hitherto supposed to be extinct, was received by the section with great interest. The skull exhibited was still invested with pieces of flesh and cartilage, which bore witness to the freshness of its condition. A skull of the great extinct turtle *Miolania* from Patagonia was also examined with much interest by zoologists, on account of the close resemblance which it bears to the specimens already known from Queensland and Lord Howe's Island. Mr. Graham Kerr's success in bringing home a complete series of stages in the development of the lung-fish *Lepidosiren*, gained for him the hearty congratulations of the Section. Mr. Garstang's account of the work already accomplished by the committee for periodically surveying the Plankton and physical conditions of the English Channel, promised well for the satisfactory completion of a most important undertaking, and the discussion on marine fish culture was of a thoroughly practical character.

One has to go back to the earlier years of the Association to find so excellent a program, from the scientific point of view, as that presented by the Geographical Section at Dover. The papers on scientific geography were many and the travel papers few, and such of the latter as were presented were up to a high standard. The address of the President, Sir John Murray, gave an admirably clear *résumé* of the chief results which have been attained in the investigation of the oceans during the last 30 years or so. The concluding portion of his address dealt with the subject of Antarctic exploration, with special reference to the proposed National Antarctic Expedition, and the greater part of the following day was devoted to a discussion of the same subject. The President's remarks and the statements brought forward in the discussion are generally regarded as expressing the views of scientific men as to what ought to be the program of the British expedition. There can be no doubt, from what took place in the Geographical Section, that the feeling among scientific geographers is that the expedition should not be a mere naval adventure, but that, as far as the funds available allow, the expedition should be so organized as to secure the largest possible gain to all departments of science interested in the Antarctic. It is to be hoped that Sir John Murray's appeal for an additional £50,000 will meet with a prompt response, as it will then be possible to send two ships, and to render the program of the enterprise complete all

round to the satisfaction of all concerned in its organization. All who heard Admiral Makaroff's paper on the wonderful work accomplished by his ice-breaker would wish, if it were possible, to send such a ship to the Antarctic, and with an available fund of £150,000 this might be possible. Naturally, with Sir John Murray in the chair, oceanography and limnology were prominent, though Sir John seemed to think that Dr. Mill's attempt to formulate a nomenclature of the bed of the ocean was somewhat premature. Notwithstanding the criticism of Mr. Crook, Sir John Farquharson's account of the last twelve years' work of the Ordnance Survey proved that the British Survey maps will stand comparison with those produced in other countries. Sir John Farquharson was unable to exhibit the magnificent series of maps which he had brought with him owing to lack of space. The papers by Mr. and Mrs. Rickmers on their journey in Central Asia and by Captain Wellby, on his remarkable journey to Southern Abyssinia and Lake Rudolf, and thence northwest to Khartum, were excellent; while Dr. Haddon's notes on his expedition to New Guinea and Borneo were a good illustration of what is meant by 'Anthropogeography.'

In the section of Economics and Statistics, the president, Mr. Henry Higgs, abstained from reviewing the progress of economic theory, and his thoughful plea for a detailed study of the actual consumption of wealth and a consideration of the ways in which it may be improved has excited considerable attention. Whether his advice will be taken remains to be seen, but, if the proceedings of the Section afford material for judging, professed economists have ceased to interest themselves in economic theory. They were strongly represented at the meeting by Professors Edgeworth, Smart, and Flux, Messrs. Cannan and Bowley, Dr. J. H. Hollander, and others, but not one contribution to economic theory was offered by any of them. The subject which now seems to draw the largest audience and the most animated discussion is what may be called municipal economics; and in the annual discussion of subjects which come under this head the Section is probably doing its most useful work. The subject of the measurement of wages and retail prices was dealt with in several papers.

Meeting under the presidency of Sir William White, chief constructor to the British Navy, it was natural that marine engineering should be the most prominent feature of the work of Section G, at Dover. In his address, the president, after dealing with the great progress of the past 60 years, not only in size of ships, but in speed and increased engine power, discussed the probable lines of advance in future, and by the help of some convincing figures showed how serious and practically insuperable were the difficulties ahead of us in the matter of greatly increased speeds for big liners and cruisers, and, in fact, for large ships generally. A paper by the Hon. C. A. Parsons, F.R.S., on the application of his now well-known steam turbines to the driving of fast passenger steamers, both for cross-Channel and for the Atlantic service, came as a convincing supplement to this portion of the president's address. In the discussion the author was able to state that the preliminary trials had thoroughly confirmed his anticipations of success. In view of the wild statements and of the misleading deductions so often made from the high speeds now attained in destroyers, it seems well to point out that Mr. Parsons, in his proposed liner of 600 feet length and 18,000 tons displacement, does not propose a greater speed than 26 knots, and to obtain this he would need, even with all the advantages he claims for his steam turbines in reduction of weight, etc., no less than 38,000-horse power, or over two-horse power

per ton of displacement; in the cross-Channel boat he proposed 30 knots. The improvement in the time of transit through the Suez Canal, due both to the widening and deepening of the original canal and to the use of the electric light for night passages, were the striking facts of Sir Charles Hartley's valuable description of the engineering features of the canal.

In the Anthropological Section, Mr. C. H. Read's address developed the idea first proposed by him at the Liverpool meeting of an Imperial bureau of ethnology. The scheme has been accepted in principle by the Government, and the administrators of native races have now the highest official encouragement to furnish reports and observations to the central institution. The bureau will stand in relation to the Ethnographical Department of the British Museum, but the Museum cannot maintain the bureau from its own resources; still less can it provide the teaching organization which Mr. Read regards as an essential part of this scheme. The solution which he proposes is to establish the bureau in a part of the Imperial Institute; to transfer the Ethnographical Department thither into the close neighborhood of the Indian and Art Museums; and to look to the University of London, established under the same roof, for a professor and a school of anthropology. Dr. Haddon and his colleagues described the Cambridge expedition to Torres Straits, of which we hope to give later some account. The papers of Dr. Garson, Mr. MacIver, and Professor Macalister illustrated in different ways the growing demand for real accuracy in anthropometry, the growing scepticism of the possibility of distinguishing races by mere linear measurements of the bones, and the stimulus which these uncertainties have given to better methods of obtaining and tabulating the data. The practical importance of this side of anthropology came out well in the discussion of the merits of measurements and of finger prints in the identification of criminals in India. Dr. Rivers's method of genealogical census and Professor Petrie's system of accurate sequence dating for antiquities are also worthy of separate mention.

The Section of Physiology was that to which the President of the Association himself specially belonged, and this may account for the numerous papers and reports which were presented at the Dover meeting. They proved how much need there was for the institution of such a Section. The papers presented were of scientific importance, but were in most cases too technical for abstracts.

In the Botanical Section the meetings were very successful, and some very interesting papers were communicated. The address of the President, Sir George King, dealt with the history and present position of Indian botany, and his remarks on the unsatisfactory training given in England to officers destined for the Indian Forest Service were received with approval. Mr. Francis Darwin's paper on the geotropic sensitiveness in plants was a most important communication, showing as it did that plants are capable of receiving a stimulus in a sensitive part which is transmitted to another part of the plant and results in a definite movement of that part. From Professor M. Ward and his pupils were received a number of papers on fungi, and Mr. A. C. Seward contributed several papers on fossil botany. Mr. Harold Wager, of Leeds, dealt with the question of sexuality in fungi, and showed that the phenomena are not only comparable to those which occur in higher plants and animals, but that the study of these forms gives an insight into the primary meaning of sexuality. One of the most important papers was that by Sir W. Thiselton-Dyer on the effect of low temperatures on the germination of seeds.

He showed that extreme cold does not interfere with their power of germination.

The Association will meet next year at Bradford, commencing on Wednesday, September 5th, with Sir William Turner as president. The meeting of 1901 will be at Glasgow, and the following meeting will probably be in Ireland.

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*ADDRESS BY THE PRESIDENT OF THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

AMONG the many questions of great theoretical importance which have engaged the attention of geologists, none has in late years awakened more interest or aroused livelier controversy than that which deals with Time as an element in geological history. The various schools which have successively arisen—Cataclysmal, Uniformitarian, and Evolutionist—have had each its own views as to the duration of their chronology, as well as to the operations of terrestrial energy. But though holding different opinions, they did not make these differences matter of special controversy among themselves. About thirty years ago, however, they were startled by a bold irruption into their camp from the side of physics. They were then called on to reform their ways, which were declared to be flatly opposed to the teachings of natural philosophy. Since that period the discussion then started regarding the age of the Earth and the value of geological time has continued with varying animation. Evidence of the most multifarious kind has been brought forward, and arguments of widely different degrees of validity have been pressed into service both by geologists and paleontologists on one side, and by physicists on the other. For the last year or two there has been a pause in the controversy, though no general agreement has been arrived at in regard to the matters in dispute. The present interval of comparative quietude seems favorable for a dispassionate review of the debate. I propose, therefore, to take, as perhaps a not inappropriate subject on which to address geologists upon a somewhat international occasion like this present meeting of the British Association at Dover, the question of Geological Time. In offering a brief history of the discussion, I gladly avail myself of the opportunity of enforcing one of the lessons which the discussion has impressed upon my own mind, and to point a moral which, as it seems to me, we geologists may take home to ourselves from a consideration of the whole question. There is, I think, a practical outcome which may be made to issue from the controversy in a combination of sympathy and coöperation among geologists all over the world. A lasting service will be rendered to our science if by well-concerted effort we can place geological dynamics and geological chronology on a broader and firmer basis of actual experiment and measurement than has yet been laid.

To understand aright the origin and progress of the dispute regarding the value of time in geological speculation, we must take note of the attitude maintained towards this subject by some of the early fathers of the science. Among these pioneers none has left his mark more deeply graven on the foundations of modern geology than James Hutton. To him, more than to any other writer of his day, do we owe the doctrine of the high antiquity of our globe. No one before him had ever seen so clearly the abundant and impressive proofs of this remote antiquity recorded in the rocks of the earth's crust. In these rocks he traced the operation of the same slow and quiet processes which he observed to be at work at present in gradually transforming the face of the existing

* Dover meeting, September, 1899.

continents. When he stood face to face with the proofs of decay among the mountains, there seems to have arisen uppermost in his mind the thought of the immense succession of ages which these proofs revealed to him. His observant eye enabled him to see "the operations of the surface wasting the solid body of the globe, and to read the unmeasurable course of time that must have flowed during those amazing operations, which the vulgar do not see, and which the learned seem to see without wonder."* In contemplating the stupendous results achieved by such apparently feeble forces, Hutton felt that one great objection he had to contend with in the reception of his theory, even by the scientific men of his day, lay in the inability or unwillingness of the human mind to admit such large demands as he made on the past. 'What more can we require?' he asks in summing up his conclusions; and he answers the question in these memorable words: "What more can we require? Nothing but time. It is not any part of the process that will be disputed; but after allowing all the parts, the whole will be denied; and for what?—only because we are not disposed to allow that quantity of time which the ablution of so much wasted mountain might require."†

Far as Hutton could follow the succession of events registered in the rocky crust of the globe, he found himself baffled by the closing in around him of that dark abysm of time into which neither eye nor imagination seemed able to penetrate. He well knew that, behind and beyond the ages recorded in the oldest of the primitive rocks, there must have stretched a vast earlier time, of which no record met his view. He did not attempt to speculate beyond the limits of his evidence. "I do not pretend," he said, "to describe the beginning of things; I take things such as I find them at present, and from these I reason with regard to that which must have been."* In vain could he look, even among the oldest formations, for any sign of the infancy of the planet. He could only detect a repeated series of similar revolutions, the oldest of which was assuredly not the first in the terrestrial history, and he concluded, as "the result of this physical inquiry, that we find no vestige of a beginning, no prospect of an end."†

*Theory of the Earth, Vol. I., p. 108.

† *Op. cit.*, Vol. II., p. 329.

This conclusion from strictly geological evidence has been impugned from the side of physics, and, as further developed by Playfair, has been declared to be contradicted by the principles of natural philosophy. But if it be considered on the basis of the evidence on which it was originally propounded, it was absolutely true in Hutton's time and remains true to-day. That able reasoner never claimed that the earth has existed from all eternity, or that it will go on existing for ever. He admitted that it must have had a beginning, but he had been unable to find any vestige of that beginning in the structure of the planet itself. And notwithstanding all the multiplied researches of the century that has passed since the immortal 'Theory of the Earth' was published, no relic of the first condition of our earth has been found. We have speculated much, indeed, on the subject, and our friends the physicists have speculated still more. Some of the speculations do not seem to me more philosophical than many of those of the older cosmogonists. As far as reliable evidence can be drawn from the rocks of the globe itself, we do not seem to be nearer the discovery of the beginning than Hutton was. The most ancient rocks that can be reached are demonstrably not the first-formed of all. They were preceded by others which we

* *Op. cit.*, Vol. I., p. 173, *note.*

† *Op. cit.*, Vol. I., p. 200.

know must have existed, though no vestige of them may remain.

It may be further asserted that, while it was Hutton who first impressed on modern geology the conviction that for the adequate comprehension of the past history of the earth vast periods of time must be admitted to have elapsed, our debt of obligation to him is increased by the genius with which he linked the passage of these vast periods with the present economy of nature. He first realized the influence of time as a factor in geological dynamics, and first taught the efficacy of the quiet and unobtrusive forces of nature. His predecessors and contemporaries were never tired of invoking the more vigorous manifestations of terrestrial energy. They saw in the composition of the land and in the structure of mountains and valleys memorials of numberless convulsions and cataclysms. In Hutton's philosophy, however, "it is the little causes, long continued, which are considered as bringing about the greatest changes of the earth."*

And yet, unlike many of those who derived their inspiration from his teaching, but pushed his tenets to extremes which he doubtless never anticipated, he did not look upon time as a kind of scientific fetich, the invocation of which would endow with efficacy even the most trifling phenomena. As if he had foreseen the use that might be made of his doctrine, he uttered this remarkable warning: "With regard to the effect of time, though the continuance of time may do much in those operations which are extremely slow, where no change, to our observation, had appeared to take place, yet, where it is not in the nature of things to produce the change in question, the unlimited course of time would be no more effectual than the moment by which we measure events in our observations."†

* Theory of the Earth, Vol. II., p. 205.

† *Op. cit.*, Vol. I., p. 44.

We thus see that in the philosophy of Hutton, out of which so much of modern geology has been developed, the vastness of the antiquity of the globe was deduced from the structure of the terrestrial crust and the slow rate of action of the forces by which the surface of the crust is observed to be modified. But no attempt was made by him to measure that antiquity by any of the chronological standards of human contrivance. He was content to realize for himself and to impress upon others that the history of the earth could not be understood, save by the admission that it occupied prolonged though indeterminate ages in its accomplishment. And assuredly no part of his teaching has been more amply sustained by the subsequent progress of research.

Playfair, from whose admirable 'Illustrations of the Huttonian Theory' most geologists have derived all that they know directly of that theory, went a little further than his friend and master in dealing with the age of the earth. Not restricting himself, as Hutton did, to the testimony of the rocks, which showed neither vestige of a beginning nor prospect of an end, he called in the evidence of the cosmos outside the limits of our planet, and declared that in the firmament also no mark could be discovered of the commencement or termination of the present order, no symptom of infancy or old age, nor any sign by which the future or past duration of the universe might be estimated.* He thus advanced beyond the strictly geological basis of reasoning, and committed himself to statements which, like some made also by Hutton, seem to have been suggested by certain deductions of the French mathematicians of his day regarding the stability of the planetary motions. His statements have been disproved by modern physics; distinct evidence, both from the earth and

* Illustrations of the Huttonian Theory, § 118.

the cosmos, has been brought forward of progress from a beginning which can be conceived, through successive stages to an end which can be foreseen. But the disproof leaves Hutton's doctrine about the vastness of geological time exactly where it was. Surely it was no abuse of language to speak of periods as being vast, which can only be expressed in millions of years.

It is easy to understand how the Uniformitarian school, which sprang from the teaching of Hutton and Playfair, came to believe that the whole of eternity was at the disposal of geologists. In popular estimation, as the ancient science of astronomy was that of infinite distance, so the modern study of geology was the science of infinite time. It must be frankly conceded that geologists, believing themselves unfettered by any limits to their chronology, made ample use of their imagined liberty. Many of them, following the lead of Lyell, to whose writings in other respects modern geology owes so deep a debt of gratitude, became utterly reckless in their demands for time, demands which even the requirements of their own science, if they had adequately realized them, did not warrant. The older geologists had not attempted to express their vast periods in terms of years. The indefiniteness of their language fitly denoted the absence of any ascertainable limits to the successive ages with which they had to deal. And until some evidence should be discovered whereby these limits might be fixed and measured by human standards, no reproach could justly be brought against the geological terminology. It was far more philosophical to be content, in the meanwhile, with indeterminate expressions, than from data of the weakest or most speculative kind to attempt to measure geological periods by a chronology of years or centuries.

In the year 1862 a wholly new light was thrown on the question of the age of our globe and the duration of geological time by the remarkable paper on the 'Secular Cooling of the Earth,' communicated by Lord Kelvin (then Sir William Thomson), to the Royal Society of Edinburgh.* In this memoir he first developed his now well-known argument from the observed rate of increase of temperature downwards from the surface of the land. He astonished geologists by announcing to them that some definite limits to the age of our planet might be ascertained, and by declaring his belief that this age must be more than 20 millions, but less than 400 millions of years.

Nearly four years later he emphasized his dissent from what he considered to be the current geological opinions of the day by repeating the same argument in a more pointedly antagonistic form in a paper of only a few sentences, entitled, 'The Doctrine of Uniformity in Geology briefly refuted.'†

Again, after a further lapse of about two years, when, as President of the Geological Society of Glasgow, it became his duty to give an address, he returned to the same topic and arraigned more boldly and explicitly than ever the geology of the time. He then declared that "a great reform in geological speculation seems now to have become necessary," and he went so far as to affirm that "it is quite certain that a great mistake has been made—that British popular geology at the present time is in direct opposition to the principles of natural philosophy."‡ In pressing once more the original argument derived from the downward increase of terrestrial temperature, he now reinforced it by two further arguments, the one based on the retardation of the earth's angular velocity by tidal friction, the

* Trans. Roy. Soc. Edin., Vol. XXIII. (1862).

† Proc. Roy. Soc. Edin., Vol. V., p. 512 (Dec. 18, 1865).

‡ Trans. Geol. Soc., Glasgow, Vol. III. (February, 1868), pp 1, 16.

other on the limitation of the age of the sun.

These three lines of attack remain still those along which the assault from physics is delivered against the strongholds of geology. Lord Kelvin has repeatedly returned to the charge since 1868, his latest contribution to the controversy having been pronounced two years ago.* While his physical arguments remain the same, the limits of time which he deduces from them have been successively diminished. The original maximum of 400 millions of years has now been restricted by him to not much more than 20 millions, while Professor Tait grudgingly allows something less than 10 millions.†

Soon after the appearance of Lord Kelvin's indictment of modern geology in 1868, the defence of the science was taken up by Huxley, who happened at the time to be President of the Geological Society of London. In his own inimitably brilliant way, half seriously, half playfully, this doughty combatant, with evident relish, tossed the physical arguments to and fro in the eyes of his geological brethren, as a barrister may flourish his brief before a sympathetic jury. He was willing to admit that "the rapidity of rotation of the earth *may* be diminishing, that the sun *may* be waxing dim, or that the earth itself *may* be cooling." But he went on to add his suspicion that "most of us are Gallios, 'who care for none of these things,' being of opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits."‡

For the indifference which their advocate thus professed on their behalf most geologists believed that they had ample justification. The limits within which the physicist would circumscribe the earth's history were so vague, yet so vast, that whether the time allowed were 400 millions or 100 millions of years did not seem to them greatly to matter. After all, it was not the time that chiefly interested them, but the grand succession of events which the time had witnessed. That succession had been established on observations so abundant and so precise that it could withstand attack from any quarter, and it had taken as firm and lasting a place among the solid achievements of science as could be claimed for any physical speculations whatsoever. Whether the time required for the transaction of this marvellous earth-history was some millions of years more, or some millions of years less, did not seem to the geologists to be a question on which their science stood in antagonism with the principles of natural philosophy, but one which the natural philosophers might be left to settle at their own good pleasure.

For myself, I may be permitted here to say that I have never shared this feeling of indifference and unconcern. As far back as the year 1868, only a month after Lord Kelvin's first presentation of his threefold argument in favor of limiting the age of the earth, I gave in my adhesion to the propriety of restricting the geological demands for time. I then showed that even the phenomena of denudation, which, from the time of Hutton downwards, had been most constantly and confidently appealed to in support of the inconceivably vast antiquity of our globe, might be accounted for, at the present rate of action, within such a period as 100 millions of years.* To my mind it has always seemed that whatever tends to

* 'The Age of the Earth,' being the Annual Address to the Victoria Institute, June 2, 1897. SCIENCE, May 12 and 19, 1899. *Phil. Mag.*, 1899.

† Recent Advances in Physical Science, p. 174.

‡ Presidential Address. *Quar. Journ. Geol. Soc.* 1869.

* *Trans. Geol. Soc. Glasgow*, Vol. III. (March 26, 1868), p. 189. Sir W. Thomson acknowledged my adhesion in his reply to Huxley's criticism. *Op. cit.*, p. 221.

give more precision to the chronology of the geologist and helps him to a clearer conception of the antiquity with which he has to deal, ought to be welcomed by him as a valuable assistance in his inquiries. And I feel sure that this view of the matter has now become general among those engaged in geological research. Frank recognition is made of the influence which Lord Kelvin's persistent attacks have had upon our science. Geologists have been led by his criticisms to revise their chronology. They gratefully acknowledge that to him they owe the introduction of important new lines of investigation, which link the solution of the problems of geology with those of physics. They realize how much he has done to dissipate the former vague conceptions as to the duration of geological history, and even when they emphatically dissent from the greatly restricted bounds within which he would now limit that history, and when they declare their inability to perceive that any reform of their speculations in this subject is needful, or that their science has placed herself in opposition to the principles of physics, they none the less pay their sincere homage to one who has thrown over geology, as over so many other departments of natural knowledge, the clear light of a penetrating and original genius.

When Lord Kelvin first developed his strictures on modern geology he expressed his opposition in the most uncompromising language. In the short paper to which reference has already been made he announced, without hesitation or palliation, that he 'briefly refuted' the doctrine of Uniformitarianism which had been espoused and illustrated by Lyell and a long list of the ablest geologists of the day. The severity of his judgment of British geology was not more marked than was his unqualified reliance on his own methods and results. This confident assurance of a distinguished physicist, together with a formidable array of mathematical formulæ, produced its effect on some geologists and paleontologists who were not Gallios. Thus, even after Huxley's brilliant defense, Darwin could not conceal the deep impression which Lord Kelvin's arguments had made on his mind. In one letter he wrote that the proposed limitation of geological time was one of his 'sorest troubles.' In another, he pronounced the physicist himself to be 'an odious spectre.'*

The same self-confidence of assertion on the part of some, at least, of the disputants on the physical side has continued all through the controversy. Yet when we examine the three great physical arguments in themselves, we find them to rest on assumptions which, though certified as 'probable' or 'very sure,' are nevertheless admittedly assumptions. The conclusions to which these assumptions lead must depend for their validity on the degree of approximation to the truth in the premises which are postulated.

Now it is interesting to observe that neither the assumptions nor the conclusions drawn from them have commanded universal assent even among physicists themselves. If they were as self-evident as they have been claimed to be, they should at least receive the loyal support of all those whose function it is to pursue and extend the applications of physics. It will be remembered, however, that thirteen years ago Professor George Darwin, who has so often shown his inherited sympathy in geological investigation, devoted his presidential address before the Mathematical Section of this Association to a review of the three famous physical arguments respecting the age of the earth. He summed up his judgment of them in the following words: "In considering these three arguments I have adduced some reasons against the validity

* Darwin's *Life and Letters*, Vol. III., pp. 115, 146.

of the first (tidal friction); and have endeavored to show that there are elements of uncertainty surrounding the second (secular cooling of the earth); nevertheless they undoubtedly constitute a contribution of the first importance to physical geology. Whilst, then, we may protest against the precision with which Professor Tait seeks to deduce results from them, we are fully justified in following Sir William Thomson, who says that 'the existing state of things on the earth, life on the earth—all geological history showing continuity of life, must be limited within some such period of past time as 100,000,000 years.' "*

More recently Professor Perry has entered the lists, from the physical side, to challenge the validity of the conclusions so confidently put forward in limitation of the age of the earth. He has boldly impugned each of the three physical arguments. That which is based on tidal retardation, following Mr. Maxwell Close and Professor Darwin, he dismisses as fallacious. In regard to the argument from the secular cooling of the earth, he contends that it is perfectly allowable to assume a much higher conductivity for the interior of the globe, and that this assumption would vastly increase our estimate of the age of the planet. As to the conclusions drawn from the history of the sun, he maintains that, on the one hand, the sun may have been repeatedly fed by infalling meteorites, and that on the other the earth, during former ages, may have had its heat retained by a dense atmospheric envelope. He thinks that 'almost anything is possible as to the present internal state of the earth,' and he concludes in these words: "To sum up, we can find no published record of any lower maximum age of life on the earth, as calculated by physicists, than 400 millions of years. From the three physical arguments, Lord Kelvin's higher limits are 1000, 400, and 500 million years. I have shown that we have reasons for believing that the age, from all these, may be very considerably underestimated. It is to be observed that if we exclude everything but the arguments from mere physics, the *probable* age of life on the earth is much less than any of the above estimates; but if the paleontologists have good reasons for demanding much greater times, I see nothing from the physicist's point of view which denies them four times the greatest of these estimates."*

This remarkable admission from a recognized authority on the physical side reechoes and emphasizes the warning pronounced by Professor Darwin in the address already quoted—"at present our knowledge of a definite limit to geological time has so little precision that we should do wrong to summarily reject any theories which appear to demand longer periods of time than those which now appear allowable."†

This 'wrong,' which Professor Darwin so seriously deprecated, has been committed not once, but again and again, in the history of this discussion. Lord Kelvin has never taken any notice of the strong body of evidence adduced by geologists and paleontologists in favor of a much longer antiquity than he is now disposed to allow for the age of the earth. His own three physical arguments have been successively restated, with such corrections and modifications as he has found to be necessary, and no doubt further alterations are in store for them. He has cut off slice after slice from the allowance of time which at first he was prepared to grant for the evolution of geological history, his latest pronouncement being that 'it was more than twenty and less than forty million years, and probably much nearer twenty than forty.'‡ But

* Rep. Brit. Assoc., 1886, p. 517.

* *Nature*, Vol. LI., p. 585, April 18, 1895.

† Rep. Brit. Assoc., 1886, p. 518.

‡ 'The Age of the Earth,' Presidential Address to the Victoria Institute for 1897, p. 10, *Phil. Mag.*, 1899.

in none of his papers is there an admission that geology and paleontology, though they have again and again raised their voices in protest, have anything to say in the matter that is worthy of consideration.

It is difficult satisfactorily to carry on a discussion in which your opponent entirely ignores your arguments, while you have given the fullest attention to his. In the present instance, geologists have most carefully listened to all that has been brought forward from the physical side. Impressed by the force of the physical reasoning, they no longer believe that they can make any demands they may please on past time. They have been willing to accept Lord Kelvin's original estimate of 100 millions of years as the period within which the history of life upon the planet must be comprised; while some of them have even sought in various ways to reduce that sum nearer to his lower limit. Yet there is undoubtedly a prevalent misgiving, whether in thus seeking to reconcile their requirements with the demands of the physicist they are not tying themselves down within limits of time which on any theory of evolution would have been insufficient for the development of the animal and vegetable kingdoms.

It is unnecessary to recapitulate before this Section of the British Association, even in briefest outline, the reasoning of geologists and paleontologists which leads them to conclude that the history recorded in the crust of the earth must have required for its transaction a much vaster period of time than that to which the physicists would now restrict it.* Let me merely remark that the reasoning is essentially based on observations of the present rate of geological and biological changes upon the earth's surface. It is not, of course, maintained that this rate has never varied in the past. But it is the only rate with which we are familiar, which we can watch and in some degree measure, and which, therefore, we can take as a guide towards the comprehension and interpretation of the past history of our planet.

It may be, and has often been said, that the present scale of geological and biological processes cannot be accepted as a reliable measure for the past. Starting from the postulate, which no one will dispute, that the total sum of terrestrial energy was once greater than it is now and has been steadily declining, the physicists have boldly asserted that all kinds of geological action must have been more vigorous and rapid during bygone ages than they are to-day; that volcanoes were more gigantic, earthquakes more frequent and destructive, mountain-upthrows more stupendous, tides and waves more powerful, and commotions of the atmosphere more violent, with more ruinous tempests and heavier rainfall. Assertions of this kind are temptingly plausible and are easily made. But it is not enough that they should be made; they ought to be supported by some kind of evidence to show that they are founded on actual fact and not on mere theoretical possibility. Such evidence, if it existed, could surely be produced. The chronicle of the earth's history, from a very early period down to the present time, has been legibly written within the sedimentary formations of the terrestrial crust. Let the appeal be made to that register. Does it lend any support to the affirmation that the geological processes are now feebler and slower than they used to be? If it does, the physicists, we might suppose, would gladly bring forward its evidence as irrefragable confirmation of the soundness of their con-

* The geological arguments are briefly given in my Presidential Address to the British Association at the Edinburgh meeting of 1892. The biological arguments were well stated, and in some detail, by Professor Poulton in his address to the Zoological Section of the Association at the Liverpool Meeting of 1896.

tention. But the geologists have found no such confirmation. On the contrary, they have been unable to discover any indication that the rate of geological causation has ever, on the whole, greatly varied during the time which has elapsed since the deposition of the oldest stratified rocks. They do not assert that there has been no variation, that there have been no periods of greater activity, both hypogene and epigene. But they maintain that the demonstration of the existence of such periods has yet to be made. They most confidently affirm that whatever may have happened in the earliest ages, in the whole vast succession of sedimentary strata nothing has yet been detected which necessarily demands that more violent and rapid action which the physicists suppose to have been the order of nature during the past.

So far as the potent effects of prolonged denudation permit us to judge, the latest mountain-upheavals were at least as stupendous as any of older date whereof the basal relics can yet be detected. They seem, indeed, to have been still more gigantic than those. It may be doubted, for example, whether among the vestiges that remain of Mesozoic or Paleozoic mountain-chains any instance can be found so colossal as those of Tertiary times, such as the Alps. No volcanic eruptions of the older geological periods can compare in extent or volume with those of Tertiary and recent date. The plication and dislocation of the terrestrial crust are proportionately as conspicuously displayed among the younger as among the older formations, though the latter, from their greater antiquity, have suffered during a longer time from the renewed disturbances of successive periods.

As regards evidence of greater violence in the surrounding envelopes of atmosphere and ocean, we seek for it in vain among the stratified rocks. Among the very oldest formations of these islands, the Torridon sandstone of North-West Scotland presents us with a picture of long-continued sedimentation, such as may be seen in progress now round the shores of many a mountain-girdled lake. In that venerable deposit, the enclosed pebbles are not mere angular blocks and chips, swept by a sudden flood or destructive tide from off the surface of the land, and huddled together in confused heaps over the floor of the sea. They have been rounded and polished by the quiet operation of running water, as stones are rounded and polished now in the channels of brooks or on the shores of lake and sea. They have been laid gently down above each other, layer over layer, with fine sand sifted in between them, and this deposition has taken place along shores which, though the waters that washed them have long since disappeared, can still be followed for mile after mile across the mountains and glens of the North-West Highlands. So tranquil were these waters that their gentle currents and oscillations sufficed to ripple the sandy floor, to arrange the sediment in laminæ of current-bedding, and to separate the grains of sand according to their relative densities. We may even now trace the results of these operations in thin darker layers and streaks of magnetic iron, zircon, and other heavy minerals, which have been sorted out from the lighter quartz-grains, as layers of iron-sand may be seen sifted together by the tide along the upper margins of many of our sandy beaches at the present day.

In the same ancient formation there occur also various intercalations of fine muddy sediment, so regular in their thin alternations, and so like those of younger formations, that we cannot but hope and expect that they may eventually yield remains of organisms which, if found, would be the earliest traces of life in Europe.

It is thus abundantly manifest that even in the most ancient of the sedimentary reg-

isters of the earth's history, not only is there no evidence of colossal floods, tides and denudation, but there is incontrovertible proof of continuous orderly deposition, such as may be witnessed to-day in any quarter of the globe. The same tale, with endless additional details, is told all through the stratified formations down to those which are in the course of accumulation at the present day.

Not less important than the stratigraphical is the paleontological evidence in favor of the general quietude of the geological processes in the past. The conclusions drawn from the nature and arrangement of the sediments are corroborated and much extended by the structure and manner of entombment of the enclosed organic remains. From the time of the very earliest fossiliferous formations there is nothing to show that either plants or animals have had to contend with physical conditions of environment different, on the whole, from those in which their successors now live. The oldest trees, so far as regards their outer form and internal structure, betoken an atmosphere neither more tempestuous nor obviously more impure than that of to-day. The earliest corals, sponges, crustaceans, mollusks, and arachnids were not more stoutly constructed than those of later times, and are found grouped together among the rocks as they lived and died, with no apparent indication that any violent commotion of the elements tried their strength when living or swept away their remains when dead.

But, undoubtedly, most impressive of all the paleontological data is the testimony borne by the grand succession of organic remains among the stratified rocks as to the vast duration of time required for their evolution. Professor Poulton has treated this branch of the subject with great fullness and ability. We do not know the present average rates of organic variation, but all the available evidence goes to indicate their extreme slowness. They may conceivably have been more rapid in the past, or they may have been liable to fluctuations according to vicissitudes of environment.* But those who assert that the rate of biological evolution ever differed materially from what it may now be inferred to be, ought surely to bring forward something more than mere assertion in their support. In the meantime, the most philosophical course is undoubtedly followed by those biologists who in this matter rest their belief on their own experience among recent and fossil organisms.

So cogent do these geological and paleontological arguments appear, to those at at least who have taken the trouble to master them, that they are worthy of being employed, not in defence merely, but in attack. It seems to me that they may be used with effect in assailing the stronghold of speculation and assumption in which our physical friends have ensconced themselves and from which, with their feet, as they believe, planted well within the interior of the globe and their heads in the heart of the sun, they view with complete unconcern the efforts made by those who endeavor to gather the truth from the surface and crust of the earth. That portion of the records of terrestrial history which lies open to our investigation has been diligently studied in all parts of the world. A vast body of facts has been gathered together from this extended and combined research. The chronicle registered in the earth's crust, though not complete, is legible and consistent. From the latest to the earliest of its chapters the story is capable of clear

*See an interesting and suggestive paper by Professor Le Conte on 'Critical Periods in the History of the Earth,' *Bull. Dept. Geology*, University of California, Vol. I. (1895), p. 313; also one by Professor Chamberlin on 'The Ulterior Basis of Time-divisions and the Classification of Geological History,' *Journal of Geology*, Vol. VI. (1898), p. 449.

and harmonious interpretation by a comparison of its pages with the present condition of things. We know infinitely more of the history of this earth than we do of the history of the sun. Are we then to be told that this knowledge, so patiently accumulated from innumerable observations and so laboriously coördinated and classified, is to be held of none account in comparison with the conclusions of physical science in regard to the history of the central luminary of our system? These conclusions are founded on assumptions which may or may not correspond with the truth. They have already undergone revision, and they may be still further modified as our slender knowledge of the sun, and of the details of its history, is increased by future investigation. In the meantime, we decline to accept them as a final pronouncement of science on the subject. We place over against them the evidence of geology and paleontology, and affirm that unless the deductions we draw from that evidence can be disproved, we are entitled to maintain them as entirely borne out by the testimony of the rocks.

Until, therefore, it can be shown that geologists and paleontologists have misinterpreted their records, they are surely well within their logical rights in claiming as much time for the history of this earth as the vast body of evidence accumulated by them demands. So far as I have been able to form an opinion, one hundred millions of years would suffice for that portion of the history which is registered in the stratified rocks of the crust. But if the paleontologists find such a period too narrow for their requirements, I can see no reason on the geological side why they should not be at liberty to enlarge it as far as they may find to be needful for the evolution of organized existence on the globe. As I have already remarked, it is not the length of time which interests us so much as the determination of the relative chronology of the events which were transacted within that time. As to the general succession of these events, there can be no dispute. We have traced its stages from the bottom of the oldest rocks up to the surface of the present continents and the floor of the present seas. We know that these stages have followed each other in orderly advance, and that geological time, whatever limits may be assigned to it, has sufficed for the passage of the long stately procession.

We, may, therefore, well leave the dispute about the age of the earth to the decision of the future. In so doing, however, I should be glad if we could carry away from it something of greater service to science than the consciousness of having striven our best in a barren controversy, wherein concession has all to be on one side and the selection of arguments entirely on the other. During these years of prolonged debate I have often been painfully conscious that in this subject, as in so many others throughout the geological domain, the want of accurate numerical data is a serious hindrance to the progress of our science. Heartily do I acknowledge that much has been done in the way of measurements and experiments for the purpose of providing a foundation for estimates and deductions. But infinitely more remains to be accomplished. The field of investigation is almost boundless, for there is hardly a department of geological dynamics over which it does not extend. The range of experimental geology must be widely enlarged, until every process susceptible of illustration or measurement by artificial means has been investigated. Field-observation needs to be supplemented where possible by instrumental determinations, so as to be made more precise and accurate, and more capable of furnishing reliable numerical statistics for practical as well as theoretical deductions.

The subject is too vast for adequate

treatment here. But let me illustrate my meaning by selecting a few instances where the adoption of these more rigid methods of inquiry might powerfully assist us in dealing with the rates of geological processes and the value of geological time. Take, for example, the wide range of lines of investigation embraced under the head of denudation. So voluminous a series of observations has been made in this subject, and so ample is the literature devoted to it, that no department of geology, it might be thought, has been more abundantly and successfully explored. Yet if we look through the pile of memoirs, articles and books, we cannot but be struck with the predominant vagueness of their statements, and with the general absence of such numerical data determined by accurate, systematic and prolonged measurement as would alone furnish a satisfactory basis for computations of the rate at which denudation takes place. Some instrumental observations of the greatest value have indeed been made, but, for the most part, observations of this kind have been too meagre and desultory.

A little consideration will show that in all branches of the investigation of denudation opportunities present themselves on every side of testing, by accurate instrumental observation and measurement, the rate at which some of the most universal processes in the geological *régime* of our globe are carried on.

It has long been a commonplace of geology that the amount of the material removed in suspension and solution by rivers, furnishes a clue to the rate of denudation of the regions drained by the rivers. But how unequal in value, and generally how insufficient in precision, are the observations on this topic! A few rivers have been more or less systematically examined, some widely varying results have been obtained from the observations, and while enough has been obtained to show the interest and importance of the method of research, no adequate supply of materials has been gathered for the purposes of accurate deduction and generalization. What we need is a carefully organized series of observations carried out on a uniform plan, over a sufficient number of years, not for one river only, but for all the important rivers of a country, and indeed for all the greater rivers of each continent. We ought to know as accurately as possible the extent of the drainage-area of each river, the relations of river-discharge to rainfall and to other meteorological as well as topographical conditions; the variation in the proportions of mechanical and chemical impurities in the river-water according to geological formations, form of the ground, season of the year and climate. The whole geological *régime* of each river should be thoroughly studied. The admirable report of Messrs. Humphreys and Abbot on the 'Physics and Hydraulics of the Mississippi,' published in 1861, might well serve as a model for imitation, though these observers necessarily occupied themselves with some questions which are not specially geological and did not enter into others on which, as geologists, we should now gladly have further information.

Again, the action of glaciers has still less been subjected to prolonged and systematic observation. The few data already obtained are so vague that we may be said to be still entirely ignorant of the rate at which glaciers are wearing down their channels and contributing to the denudation of the land.

The whole of this inquiry is eminently suitable for combined research. Each stream or glacier, or each well-marked section of one, might become the special inquiry of a single observer, who would soon develop a paternal interest in his valley and vie with his colleagues of other valleys in the fullness and accuracy of his records.

Nor is our information respecting the op-

erations of the sea much more precise. Even in an island like Great Britain, where the waves and tides effect so much change within the space of a human life-time, the estimates of the rate of advance or retreat of the shore-line are based for the most part on no accurate determinations. It is satisfactory to be able to announce that the Council of this Association has formed a Committee for the purpose of obtaining full and accurate information regarding alterations of our coasts, and that with the sanction of the Lords of the Admiralty, the coöperation of the Coast-guard throughout the three kingdoms has been secured. We may, therefore, hope to be eventually in possession of trustworthy statistics on this interesting subject.

The disintegration of the surface of the land by the combined agency of the subaërial forces of decay is a problem which has been much studied, but in regard to whose varying rates of advance not much has been definitely ascertained. The meteorological conditions under which it takes place differ materially according to latitude and climate, and doubtless its progress is equally variable. An obvious and useful source of information in regard to atmospheric denudations is to be found in the decay of the material of buildings of which the time of erection is known, and in dated tombstones. Twenty years ago I called attention to the rate at which marble gives way in such a moist climate as ours, and cited the effects of subaërial waste as these can be measured on the monuments of our graveyards and cemeteries.* I would urge upon town-geologists, and those in the country who have no opportunities of venturing far afield, that they may do good service by careful scrutiny of ancient buildings and monuments. In the churchyards they will find much to occupy and interest them, not, however, like Old Mortality, in repairing the tombstones, but in tracing the ravages of the weather upon them, and in obtaining definite measures of the rate of their decay.

* *Proc. Roy. Soc. Edin.*, Vol. X. (1879–80), p. 518.

The conditions under which subaërial disintegration is effected in arid climates, and the rate of its advance, are still less known, seeing that most of our information is derived from the chance observations of passing travelers. Yet this branch of the subject is not without importance in relation to the denudation, not only of the existing terrestrial surface, but of the lands of former periods, for there is evidence of more than one arid epoch in geological history. Here, again, a diligent examination of ancient buildings and monuments might afford some, at least, of the required data. In such a country as Egypt, for instance, it might eventually be possible to determine from a large series of observations what has been the average rate of surface-disintegration of the various kinds of stone employed in human constructions that have been freely exposed to the air for several thousand years.

Closely linked with the question of denudation is that of the deposition of the material worn away from the surface of the land. The total amount of sediment laid down must equal the amount of material abstracted, save in so far as the soluble portions of that material are retained in solution in the sea. But we have still much to learn as to the conditions, and especially as to the rate, of sedimentation. Nor does there appear to be much hope of any considerable increase to our knowledge until the subject is taken up in earnest as one demanding and justifying a prolonged series of well-planned and carefully executed observations. We have yet to discover the different rates of deposit, under the varying conditions in which it is carried on in lakes, estuaries, and the sea. What, for instance, would be a fair average for the rate at which the lakes of each country of Europe are now

being silted up? If this rate were ascertained, and if the amount of material already deposited in these basins were determined, we should be in possession of data for estimating not only the probable time when the lakes will disappear, but also the approximate date at which they came into existence.

But it is not merely in regard to epigene changes that further more extended and concerted observation is needed. Even among subterranean movements there are some which might be watched and recorded with far more care and continuity than have ever been attempted. The researches of Professor George Darwin and others have shown how constant are the tremors, minute but measurable, to which the crust of the earth is subject.* Do these phenomena indicate displacements of the crust, and, if so, what in the lapse of a century is their cumulative effect on the surface of the land?

More momentous in their consequences are the disturbances which traverse mountain-chains and find their most violent expression in shocks of earthquake. The effects of such shocks have been studied and recorded in many parts of the world, but their cause is still little understood. Are the disturbances due to a continuation of the same operation which at first gave birth to the mountains? Should they be regarded as symptoms of growth or of collapse? Are they accompanied with even the slightest amount of elevation or depression? We cannot tell. But these questions are probably susceptible of some more or less definite answer. It might be possible, for instance, to determine with extreme precision the heights above a given datum of various fixed points along such a chain as the Alps, and by a series of minutely accurate measurements to detect any upward or downward deviation from these heights. It is quite conceivable that throughout the whole historical period some deviation of this kind has been going on, though so slowly, or by such slight increments at each period of renewal, as to escape ordinary observation. We might thus learn whether, after an Alpine earthquake, an appreciable difference of level is anywhere discoverable, whether the Alps as a great mountain-chain are still growing or are now subsiding, and we might be able to ascertain the rate of the movement. Although changes of this nature may have been too slight during human experience to be ordinarily appreciable, their very insignificance seems to me to supply a strong reason why they should be sought for and carefully measured. They would not tell us, indeed, whether a mountain-chain was called into being in one gigantic convulsion, or was raised at wide intervals by successive uplifts, or was slowly elevated by one prolonged and continuous movement. But they might furnish us with suggestive information as to the rate at which upheaval or depression of the terrestrial crust is now going on.

* Report Brit. Assoc., 1882, p. 95.

The vexed questions of the origin of Raised Beaches and Sunk Forests might in like manner be elucidated by well-devised measurements. It is astonishing upon what loose and unreliable evidence the elevation or depression of coast-lines has often been asserted. On shores where proofs of a change of level are observable it would not be difficult to establish by accurate observation whether any such movements are taking place now, and, if they are, to determine their rate. The old attempts of this kind along the coasts of Scandinavia might be resumed with far more precision and on a much more extended scale. Methods of instrumental research have been vastly improved since the days of Celsius and Linnaeus. Mere eye-observations would not supply sufficiently accurate results. When the datum-line has been determined with rigorous accuracy, the minutest changes of

level, such as would be wholly inappreciable to the senses, might be detected and recorded. If such a system of watch were maintained along coasts where there is reason to believe that some rise or fall of land is taking place, it would be possible to follow the progress of the movement and to determine its rate.

But I must not dwell longer on examples of the advantages which geology would gain from a far more general and systematic adoption of methods of experiment and measurement in elucidation of the problems of the science. I have referred to a few of those which have a more special bearing on the question of geological time, but it is obvious that the same methods might be extended into almost every branch of geological dynamics. While we gladly and gratefully recognize the large amount of admirable work that has already been done by the adoption of these practical methods, from the time of Hall, the founder of experimental geology, down to our own day, we cannot but feel that our very appreciation of the gain which the science has thus derived, increases the desire to see the practice still further multiplied and extended. I am confident that it is in this direction, more than in any other, that the next great advances of geology are to be anticipated.

While much may be done by individual students, it is less to their single efforts than to the combined investigations of many fellow-workers, that I look most hopefully for the accumulation of data towards the determination of the present rate of geological changes. I would, therefore, commend this subject to the geologists of this and other countries as one in which individual, national, and international coöperation might well be enlisted. We already possess an institution which seems well adapted to undertake and control an enterprise of the kind suggested. The International Geological Congress, which brings together our associates from all parts of the globe, would confer a lasting benefit on the science, if it could organize a system of combined observation in any single one of the departments of inquiry which I have indicated, or in any other which might be selected. We need not at first be too ambitious. The simplest, easiest, and least costly series of observations might be chosen for a beginning. The work might be distributed among the different countries represented in the Congress. Each nation would be entirely free in its selection of subjects for investigation, and would have the stimulus of coöperation with other nations in its work. The Congress will hold its triennial gathering next year in Paris, and if such an organization of research as I have suggested could then be inaugurated, a great impetus would thereby be given to geological research, and France, again become the birthplace of another scientific movement, would acquire a fresh claim to the admiration and gratitude of geologists in every part of the globe.

Archibald Geikie.

RESEARCHES IN PRACTICE AND HABIT.

The object of this investigation was to ascertain the results of practice in voluntary movements, repeating the same movements an equal number of times each day until approximately the highest degree of perfection attainable was reached.

1. *Triangular movement of the arm.*—The first experiment consisted in tapping continuously at the corners of an equilateral triangle whose sides measured 20^{cm}. The tests each day lasted only a short time; they were performed from 6 to 11 days by seven persons.

The results of the experiment showed that the greatest gains in rapidity of triangular movements of the hand as well as in the regularity of successive movements were made in the early part of the practice. The percentage of gain in speed rapidly de-

creased, being 20% for the second day, 10% for the fifth, and 5% for the ninth day. The probable error was used as a measure of irregularity. The percentage of decrease in irregularity of successive movements was not so large in the first part of practice as the percentage of gain in speed; but after the fourth day the percentage of the decrease had grown until it exceeded the percentage of increase in rapidity, thus demonstrating that the psychological order of development in voluntary movement is (1) rapidity, and (2) regularity.

The results also showed that during each practice period the subject constantly increased in speed and regularity of movement until the setting in of fatigue. However, when the exercise was continued after a short interval there was a renewal of the effort and the same results were observed to occur, though the period was much shorter than in the former case. These periods of renewal of energy were observed to become shorter each time until they came to affect almost every alternate movement.

II. *Drawing circles.*—This experiment consisted in making circles with the free-arm movement. A true circle, drawn with a compass, 60^{mm} in diameter was placed before the subject as a copy. Preliminary tests showed that ten circles at one sitting gave the best general results. The tests were made on seven subjects, extending over six days.

The results showed that with the right hand most of the subjects gained in smoothness of contour in their drawings, both during the progress of each practice and from day to day; with the left hand the results were more irregular.

Though all gained in the smoothness of contour of their curves, yet all did not make them of a size corresponding to that of the copy. These results brought out three types of practice: (1) That in which the subject decreased the size of the circle, both during the progress of each experiment and from day to day; (2) that in which the size of the circle was increased during the experiment, but decreased from day to day; (3) that in which there was but little variation from the copy either during the progress of the experiment or from day to day. The first two classes were those who regarded more carefully the smoothness of contour of their own drawn curves than they did their correspondence in size to that of the copy. The third class were those who directed their attention more especially to the size of the curve and who closely observed the copy each time before beginning to draw their own curves.

The results also showed an important principle bearing on pedagogy—that a short exercise often repeated is the best method of practice for rapid development of accurate adjustment of the muscles. Long practice at writing, drawing, etc., seems to be time and energy wasted. Not only are inattentive habits cultivated, but every wrong adjustment gains a place in the chain of subconscious memories, and, therefore, delays the development of the control over the muscles for accurate adjustments.

III. *Development of central and untrained muscles and less adapted joints.*—This experiment consisted in tapping continuously with the large toe until it was completely fatigued. The make and break contacts of an electric key were connected with markers so that each movement of the key was recorded on the smoked surface of a revolving drum. In this way each phase of the toe's movement could be measured; the phases were four, namely, the downward movement, the downward rest, the upward movement and the upward rest.

The average tap-time of the subject studied was on the first day 436^{σ}; this very regularly decreased until at the close of the practice it was 212^{σ}. Likewise, the prob-

able error decreased from 103^{σ} to 35^{σ}. Moreover, the upward rest was longer in the first part of the practice than the other three phases combined; but at the close of the series it was the same as the downward rest, thus showing that the greatest gains in voluntary activity are those resulting from the practice of the weakest and less exercised muscles.

IV. *Estimation of time.*—After a number of preliminary tests the intervals, 82 Σ, 100 Σ and 164 Σ were chosen. The practice lasted from 8 to 16 days, on seven subjects.

The results justify the following conclusions: (1) The estimate of a given interval varies for different individuals both with and without practice. (2) Practice on the same interval may cause the variation from the given interval to increase with one person and decrease with another. (3) Time-estimate is a personal factor depending upon (*a*) the nature of the person, whether of an impulsive or quiet temperament, and (*b*) upon the point of the fixation of the attention, whether to the sensory or the motor side. (4) There is no indifference 'point' from which the subject does not vary with long continued practice. The changes that practice produces in the estimation of time are probably due to fixing the attention on the movement to be performed, in which case the estimate is shortened in accordance with the growth of automatic control, or to the sensory side, in which case the time-estimate is made longer by practice.

V. *Regulated rhythmical action.*—In arranging apparatus for this experiment the probable error was found for the EDISON phonograph to range from 0.2% to 0.7%; for the LUDWIG kymograph by BALTZAR, from 0.2% to 2.0%; for a drum run by an EDISON motor driven by carefully tended EDISON-LALANDE batteries, from 0.1% to 0.3%. The PFEIL marker was found at a break of the circuit to have a latent time ranging from $1.1 \pm 0.09^{\sigma}$ with the magnet cores distant from the armature to $14.7^{\sigma} \pm 0.03^{\sigma}$ with the cores close to the armature. At a make the latent time ranged from $1.8^{\sigma} \pm 0.1^{\sigma}$ to $1.3^{\sigma} \pm 0.5^{\sigma}$. With this marker the make is nearly as good as the break except for its slightly greater irregularity. The DEPREZ marker from VERDIN showed a latent time at the break of $3.8^{\sigma} \pm 0.07^{\sigma}$ and of $2.5^{\sigma} \pm 0.64^{\sigma}$ at the make. Changes in the adjusting spring did not make any great change in the figures. The probable error of the spark records was found to be $\pm 0.25^{mm}$ independent of the speed of the drum.

In beating time in unison with a sounder-click each subject had his own constant error; this was generally negative; that is, the subjects generally beat time before the click occurred. With practice the negative constant error tended steadily to decrease, to become positive and to increase positively. The irregularity steadily decreased.

VI. *Free rythmical action.*—The seven subjects were required to beat time without any objective signal. The interval chosen at the start was unintentionally shortened with the progress of the experiment; it was also shortened from day to day. The irregularity decreased in like manner.

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NATHAN RUSSELL HARRINGTON.

NATHAN R. HARRINGTON, of Cleveland, Ohio, died in the Sudan on July 26, 1899. He was acting for the second time as leader of the Senff Zoological Expedition, sent out under the direction of Columbia University, through the liberality of Mr. Charles H. Senff, of New York City. The party consisted of Mr. Harrington, Instructor in Biology in Western Reserve University;

Dr. Reid Hunt, of the Johns Hopkins Medical School, and Mr. F. B. Sumner, fellow in Columbia University. Their chief object was to procure the long coveted eggs and early stages in development of Polypterus bichir of the Nile and other African rivers, one of the most ancient and least modified types of living fishes, and one of the most interesting vertebrates whose development yet remains to be studied by modern zoological methods.

Last year Mr. Harrington and Dr. Hunt explored Lake Menzaleh and several hundred miles of the river north of Damietta, spent two months at Mansourah, forty miles from the sea; made many observations on Polypterus alive, and brought home valuable material illustrating the anatomy of this and other Nile fishes. They found, however, that eggs of Polypterus obtained as late as August 30th, were still immature, and they were obliged to come away without getting the embryological stages sought for.

Harrington returned from this expedition with a wider knowledge of the world, a greater circle of friends and a keener zeal to extend the bounds of zoology. Although he was just beginning his career as a teacher and a great variety of work was pressing to be done, the Nile country was ever in his mind, and great was his satisfaction when he was again sent into the field.

Letters to friends during the early weeks of summer showed that new obstacles had arisen which threatened to remove every chance of success. The fish were scarce in the lower Nile and the region traversed by the upper Nile, where they were supposed to abound, was not yet open to travelers. After destroying the rule of the Mahdi, the English authorities were naturally reluctant to admit strangers to the newly recovered territory. Harrington's earnestness and tact however prevailed, and the party was permitted to proceed to Atbara, a small village and military post 1200 miles north of Cairo by river.

The circumstances of Harrington's illness and death have been told in the letters of Dr. Hunt, and from them we are permitted to narrate the following facts. Early in July Harrington went up the Atbara river with a member of his party and spent a night in the desert, where they were overtaken by a dust storm. A slight indisposition following this exposure finally led to an attack of Nile fever which ended fatally in spite of the devoted energies of his friends and Dr. Nickerson, the British Surgeon of the Post. He was borne to the grave by British soldiers attended by their officers, amid the strains of martial music, and was laid to rest in the little cemetery on the edge of the desert near the grave of Mr. Cross, the late war correspondent in the Sudan campaign.

The death of this young man calls to mind another young American zoologist of great promise, Adam T. Bruce, whose death also occurred in Egypt, twelve years ago. As with Bruce, Harrington's scientific and academic career had just begun. Though born in Massachusetts—in Somerville, December 22, 1870, the son of John and Emma Harrington—he was virtually a Cleveland boy, and was graduated from the West High School in 1889. He received the degree of Bachelor of Arts in 1893 and later that of Master of Arts from Williams College. The years 1893–1898 were passed at Columbia University, with the exception of a year as assistant in the laboratory at Williamstown, in the capacity of graduate student, assistant and fellow. During this interval his summers were spent in study at Woods Hole, and as a member of the Zoological Expeditions sent out by Columbia University, to Puget Sound and Alaska. These were followed by the Senff Expeditions to Africa in 1898–1899, as already recorded. In 1898 he was appointed Instruc-

tor in the College for Women, Western Reserve University.

Harrington's most elaborate paper on 'The Calciferous Glands of the Earthworm, with Appendix on the Circulation' was in press at the time of his death, and had been accepted as a thesis for the degree of Doctor in Philosophy, which he had hoped soon to receive from Columbia University. An important paper on Amœba and its reaction to the stimulus of light waves of different intensities, written in collaboration with Mr. Leaming, was published during the past summer. The following briefer articles testify to his energy and enthusiasm as a field naturalist; 'Observations on the Plankton of Puget Sound' with the collaboration of his ever devoted friend, the late Professor Peck; 'Notes on the distribution and habits of some Puget Sound Invertebrates,' and on 'Nereids commensal with Hermit Crabs.'

All who knew Harrington will agree that his character, courage and earnestness in the pursuit of knowledge, which led to the sacrifice of his life are well worthy of permanent record. His sympathetic and generous mind, his capacity for friendship, his industry and zeal are endowments which any young man would be fortunate to possess. He has left an honorable name in zoology, more lasting than the simple cross which now casts its shadow on his grave.

F. H. H.

SCIENTIFIC BOOKS.

The University Geological Survey of Kansas. Special report of coal. By ERASMUS HAWORTH, assisted by W. R. CRANE, Vol. III., Topeka. J. S. Parks, State Printer. 1898. 347 pp. 70 pl. 55 Figs.

Part I. of this volume, by Professor Haworth, is a general description of the Kansas Coal Measures, which the author divides into Upper and Lower, embracing seven formations with twenty-five subordinate divisions. Some of the latter will be subdivided in turn when further studies have been made. The total thickness is not far from 3,000 feet.

The Lower Coal Measures include the Cherokee and Marmaton formations. The Cherokee, 400 to 500 feet thick, consists mostly of shales but contains some irregular limestones and some sandstone beds of economic interest. The coal beds are important, being those mined at Pittsburg, Fort Scott and Columbus, and are available in an area of about 12,000 square miles. The Cherokee covers a wide space in Indian Territory, extends into Iowa to form part of the Des Moines formation, and Professor Haworth is inclined to think that the important coal fields of Arkansas may belong to the same horizon.

The Marmaton consists of alternating limestones and shales. The lower and middle limestones, Oswego and Pawnee, are persistent, but the intervening Labette shales are irregular in distribution. The upper limestone, the Altament, is thin and not persistent, so that the Pleasanton shales, divided at some localities by the limestone, are unbroken over a large area. The lower division of the Oswego limestone is the well-known Fort Scott cement rock A few coal beds occur in the Marmaton, but thus far they seem to be unimportant.

The remaining five formations belong to the Upper Coal Measures as grouped by Professor Haworth.

The Pottawatomie consists of three limestones, Erie, Iola and Garnett, separated by the Thayer and Lane shales. The Erie limestones, having a maximum thickness of 225 feet, are usually triple with intervening shales, which thicken southwardly at the expense of the limestones until the latter become insignificant. The upper limestone is cherty and all are very fossiliferous. The Thayer shales have an extreme thickness of 200 feet but thin northward, so that the Iola limestone, which thickens in that direction to 200 feet, is at length practically continuous with the upper Erie. The Lane shales and Garnett limestones are somewhat irregular in their variations, but the latter, owing to erosion of the overlying shales, is exposed over a great area. This formation contains no coal of economic importance.

The Douglas begins with the Lawrence shales, varying from 300 to 800 feet, the greater thickness being at the south. In this direction it becomes largely sandstone, for a well south from the Neosho river showed 670 feet of sandstone in a total thickness of about 800 feet. Some useful coal beds are in these shales but they exhibit great variations. The Oread limestones in two beds, each 8 to 20 feet thick, are the upper member of the Douglas formation.

The higher formations, Shawnee, Wabaunsee and Cottonwood, consist of sandstones, shales and limestones, to many of which specific designations have been assigned, but all alike appear to be irregular in thickness and distribution. Generally speaking, the shales are thin in the southern portion of the State and there the limestones have not been followed out satisfactorily; but, northward, the shales are thicker and the relations of the limestones are clearer. Fossils are abundant in the limestones to the top of the Shawnee. The Osage shales at the top of the Shawnee contain the important coal beds mined at Osage City, Peterton, Scranton and Carbon; but coal appears to be absent from the Wabaunsee and Cottonwood.

This part of the volume ends with a chapter explaining the nomenclature employed, and showing, as far as possible, the relations of the Kansas formations to those in adjacent states. One is tempted here to discuss the general subject of nomenclature with especial reference to the present craze for manufacture of new terms, but the temptation must be resisted, for the topic is too important and too attractive to be treated incidentally within the limits of a book notice. One may say, however, that unless some check is placed upon indulgence in this practice, a volume half as large as an unabridged dictionary will hardly suffice for definition of synonyms half a century hence. If geologists in charge of extensive areas would make a general reconnaissance before beginning detailed work, and if the geologists of adjoining states would work up in company the areas along boundary lines, some agreement might be reached respecting names. Certainly something ought to be done to stop the process of making independent classifications for petty areas and the application of different names to a single bed of coal, limestone or sandstone. This, of course, would lessen the amount of apparently original matter in new reports, but it would lessen to a wonderful degree the labor of those who have to use reports of several states or areas during studies in comparative geology. Professor Haworth's chapter, which is responsible for this digression, is useful, as it gives some understanding of the already annoying synonymy in some of the western states. Respecting some essential points in this chapter, relating to differences between his grouping and that of other investigators, the writer can have no opinion at present; he is too far away from the scene of strife.

The second part of the volume, by Mr. W. R. Crane deals with the economic side of the Coal Measures. It gives a detailed description of the beds now mined, belonging to the Cherokee and Osage shales. Little work has been done on beds in the intervening formations, but Mr. Crane evidently believes that some of those will be utilized. He gives a careful review of the chemical and physical properties of the Kansas coals, based on analyses and prolonged experiment. The coals show a decrease in fixed carbon in passing from south to north, as well as from east to west, with a decrease in calorific power. Mr. Crane suggests that this change is due to the facts that the beds at the south and east are older than the others, and that they have been subjected to orographic action while the others have not. A chapter is given upon clay veins, which are thought to be due to earth tremors, by which the coal was fractured and the clay pressed into the cavity. The irregular sub-conical or bell-shaped protrusions from the roof are explained as filled depressions. Some of these are interesting as they have a thin casing of anthracite coal. The coal output of the state has grown from 1,211,057 tons in 1885, to 3,291,806 tons in 1897. Mr. Crane gives descriptions of methods of mining and drainage, as well as of machinery; a directory of the mines in the state; and concludes his work with a summary of the mining laws of the state.

The volume is illustrated elaborately and has an index of 11 pages, with double columns. It is a useful contribution to the advancement of the economic interests of Kansas, and is of a

type to justify fully the expenditure. Unfortunately it is disfigured by a great number of typographical errors, for most of which the authors are, clearly, not responsible. A reform in public printing offices is necessary, for, in too many cases, reports are a source of annoyance and confusion of face to those who prepare them.

JOHN J. STEVENSON.

Les matières colorantes azoïques. GEORGES F. JAUBERT. Docteur ès Sciences, ancien Préparateur de Chimie à l'École Polytechnique. Petit in-8. (*Encyclopédie scientifique des aide-mémoire.*)

This little book appears as one of the volumes in the 'Encyclopédie scientifique des aide-mémoire,' now being published in Paris under the direction of M. Léauté, Member of the Institute. It is a sequel to a previous volume in the collection, and by the same author, entitled 'L'Industrie du goudron de houille.'

The subject matter is divided into the following chapters: 1. Nitro colors; 2. Azoxy colors; 3. Azo derivatives; 4. Aminoazo colors; 5. Oxyazo colors; 6. Azo colors dyeing upon mordants; 7. Polyazo colors derived from monamines; 8. Polyazo colors derived from diamines. The chapters on the Nitro and Azoxy colors are inserted as introductory to the Azo colors. The few pages of text present are devoted to a brief statement of the most important general properties of the Nitro, Azoxy, and Azo dyes; while the body of the work is made up of a tabular classification of the more prominent Azo colors, under the following column headings: Scientific and trade name; method of preparation; chemical formula, empiric and constitutional; literature, patents, etc., properties, reactions, etc., industrial application. It will thus be seen that the classification is practically the same as that made familiar to all color chemists by the tables of Schultz and Julius, and also used by Hehne, Green, Seyewetz and Sisley, and others. The book is, however, of a much more convenient size than the work of Schultz and Julius, although its scope is more limited. The newer Tetrazo colors, which have played such a prominent part in the substantive dyeing of cotton, are very fully listed. Several typographical errors will be found in the text and in the constitututional formulas.

Dealing, as it does, with the most numerous and the most important group of all artificial dyestuffs, the Azo Colors, this succint classification should prove most useful both to the student and to the manufacturer.

M. T. B.

A Century of Vaccination and What it Teaches. By W. SCOTT TEBB. London, Swan, Sonnerschein & Co. 1899. Second Edition.

In this book of 403 pages, Dr. Tebb presents at considerable length the usual anti-vaccination arguments, directing them by English examples especially to an English audience, and attacks the compulsory vaccination common in England before the law of 1898. Much of the space in the book is taken up with settled questions or matters not directly concerned in the point at issue; for example thirty pages discuss admittedly inconclusive experiments performed about 1800, thirty are spent on the unsanitary conditions of England in the last century, and of any place in war time, and twenty-six more give examples of small-pox occurring after vaccination and revaccination.

Dr. Tebb's reasoning is three-fold: First, that an attack of cow-pox does not secure immunity against small-pox because the latter disease sometimes follows the former; second, that serious injuries are produced by vaccination, and third that even if immunity could be gained by vaccination, compulsion would be unjustifiable. Immunity from any disease is a clinical fact not yet by any means fully understood; and it is well known both that some persons variously estimated at from 1 to 2 per cent. are naturally immune to small-pox, just as there are some immune to almost every other infectious disease, and that small-pox sometimes occurs and even proves fatal after both vaccination and revaccination and after a previous attack of small-pox. All now claimed is that successful vaccination confers against small-pox an almost absolute immunity for six months, and then further for an unknown and variable length of time a certain degree of immunity which is greater than can be gained in any other way except, by taking the disease. The

author attacks the argument for vaccination founded on the diminution in the amount of small-pox during this century by pointing out that typhus fever without the help of vaccination has also been much reduced in prevalence in the same time, and that both diseases are less frequent on account of better sanitary conditions. The comparison of typhus fever to small-pox, however, is deceptive first because as the clinical separation of typhus from typhoid fever became general only about the middle of this century, the reduction in typhus cannot be properly estimated, and second, because the improvement in sanitation does not apply equally to both. Crowding in filthy and unventilated rooms is necessary for the development of 'camp,' 'jail' or 'ship' fever, but small-pox for centuries went into the palace as well as into the hovel. The circle of infection of typhus fever is small, that of small-pox is large. Dr. Tebb's mode of reasoning is capitally illustrated by the following: "I have shown that a part of the decline of small-pox and especially that part which has taken place in children is not necessarily a saving of life, but only a shifting of the mortality on to some other disease such as measles or whooping cough." According to this reasoning, as the children probably have to die any how from some disease, they may as well die from small-pox.

The author devotes a chapter to the discussion of epidemics in various English towns, and points out that the epidemics occur in well vaccinated just as in poorly vaccinated places, and that they can be controlled without recourse to vaccination. To obtain all the facts about all the places mentioned would be a long task, but the vital facts about two of his examples, Leicester and Sheffield are well known. In unvaccinated Leicester, during the epidemic of 1892–1893, there were 21 deaths, 19 in unvaccinated and 2 in vaccinated persons over ten years old. In well vaccinated Sheffield in the epidemic of 1887–1888, there were 68,000 vaccinated children of whom ½ per cent. were attacked and 2,200 unvaccinated children of whom 10 per cent. were attacked; there were also about 200,000 vaccinated persons over ten years of age of whom 2 per cent were attacked and about 3,500 unvaccinated persons of whom 9 per cent. were attacked. The above well illustrates the established fact that vaccination protects somewhat for years, but only absolutely for from 6 to 8 months.

A long chapter which embodies the second argument is that devoted to vaccinal injuries. To clear the way for criticism of this it may be said that there is no dispute that injuries sometimes follow vaccination, that skin eruptions are moderately frequent, and that all varieties of sepsis are possible when the wound is made or cared for in an unclean way or when infected virus is inserted. Thirty pages are, however, given up to proved and unproved cases of so-called vaccino-syphilis. The truth with regard to this infection is that invaccination of syphilis is possible when vaccination is done from arm to arm, probably impossible and certainly unknown when done with calf virus. Moreover in the 5¼ million primary vaccinations done during the session of the Royal Commission in England, 1889–96, there was not a single case proved, and every alleged case was investigated. Twenty-one pages give some account of the contradictory evidence relating to the invaccination of leprosy. If this invaccination is possible when done from arm to arm, an assumption which has not been proved, yet it has at present no public importance in England or the United States. Tuberculosis and tetanus consume eight pages, yet there is no case on record in which tuberculosis was ever conveyed by vaccination, and although there have been several cases where tetanus has been alleged to have followed vaccination, yet even granting that this is so, it simply enforces the rule that vaccination should be only performed in a cleanly way.

The third argument of Dr. Tebb against compulsion may, now that compulsion no longer exists, be left as the expression of his individual opinion.

For information relative to some of the above questions, the writer wishes to thank Dr. J. H. Huddleston, who has charge of the vaccine laboratory of the New York City Health Department.

W. H. Park.
New York.

GENERAL.

The U. S. National Museum has just published a careful translation, by Mr. E. O.

Hovey, of Dr. Salvatore Lo Bianco's detailed account of the methods employed at the Naples aquarium for preserving invertebrates. The many who have admired the beautiful specimens sent out from that institution will be glad to have this paper, although it is evident that the factor of patience must enter largely into most of the processes described. The article is prefaced by a brief account of the aquarium and its work.

THE publication is announced by Archibald Constable & Co., of a *Physical Atlas*, prepared under the direction of Mr. J. G. Bartholomew, of the Edinburgh Geographical Institute. The work will be in seven volumes as follows: I. Geology; II. Orography, Hydrography and Oceanography; III. Meteorology; IV. Botany; V. Zoology; VI. Ethnography and Demography; VII. General Cosmography and Terrestrial Magnetism. The atlas of Berghaus will to a certain extent be used, but the plates will be larger in size and special attention will be paid to phenomena of interest to English and American students. The volume on meteorology is promised for the present year and the others are expected to follow in rapid succession.

BOOKS RECEIVED.

Statistics and Economics. RICHMOND MAYO-SMITH. New York and London, The Macmillan Company. 1899. Pp. xiii+467. $3.00.

The Principles of Differential Diagnosis. FRED. J. SMITH. New York and London, The Macmillan Company. 1899. Pp. ix+353. $2.00.

Résistance électrique et fluidité. GOURÉ DE VILLEMONTÉE. Paris, Gauthier-Villars. 1899. Pp. 188. 3 fr.

Essais des huiles essentielles. HENRI LABBÉ. Paris, Gauthier-Villars. 1899. Pp. 108.

Le café culture—manipulation, production. HENRI LECOMTE. Paris, Georges Carré and C. Naud. 1899. Pp. vi+334. 5 fr.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *National Geographic Magazine* for October opens with an illustrated article on 'Life on a Yukon Trail,' by Professor Arthur P. Dennis, of Northampton, Mass. Mr. Gifford Pinchot, the Forester of the U. S. Department of Agriculture, in an illustrated paper, 'The Relation of Forests and Forest Fires,' describes the effect of forest fires as modifiers of the composition and mode of life of the forest. A. J. Henry, Chief of the Division of Records, U. S. Weather Bureau, contributes a study of the fluctuations in the surface level of the Great Lakes, especially interesting at the present time owing to the near completion of the Chicago drainage canal. The contents of the number also include 'Tides of Chesapeake Bay,' by E. D. Preston; 'Calculations of Population in June, 1900,' by Henry Farquhar, a paper read before Section I. of the American Association for the Advancement of Science, Columbus, August 22d; 'Peary's Work and Prospects,' by H. L. Bridgeman, Secretary of the Peary Arctic Club. There are a number of briefer articles, 'Peary's Explorations in 1898–1899,' 'The Definite Location of Bouvet Island,' and 'The California and Nevada Boundary.'

Bird Lore for October has for its opening article an account of the origin and work of 'The American Ornithologists' Union,' by J. A. Allen, accompanied by a plate showing the founders of the society, comprising some of the men whose names are familiar to every student of American ornithology. 'American Bitterns' consists of two plates of the young, one and two weeks old, from photographs by E. H. Tabor and F. W. Chapman. Henry Van Dyke contributes a poem 'The Angler's Reveille,' Robert W. Hagner an article on 'The Prairie Horned Lark,' and C. F. Hodge notes 'A Pleasant Acquaintance with a Hummingbird.' H. M. Collins describes 'A Peculiarity of a Caged Skylark,' and Anna Harris Smith and C. F. Hodge describe 'The Ethics of Caging Birds.' Isabella McC. Lemmon writes of 'Oliver Twist, Catbird,' for young observers, and there are numerous notes and book reviews. Under the section devoted to Audubon Societies the wearing of quill feathers of the eagle and pelican is justly deprecated, and fac-simile and sketch of Audubon's seal, the wild turkey, is given.

DISCUSSION AND CORRESPONDENCE.

THE PROPOSED CARD CENTRALBLATT OF PHYSIOLOGY.

TO THE EDITOR OF SCIENCE: The volume of scientific literature is increasing at a rate that

is positively appalling. The difficulty encountered by a student seeking information in any important library to-day lies more in differentiating what he wants from the mass of material at hand than in integrating the results of his search. As a consequence, the sciences of classification and indexing are becoming daily more important, and have already reached a high pitch of development. But existing card catalogues (and none but *card* catalogues deserve to be considered in this connection), even when including a well-arranged subject-index, still leave an immense amount of labor which might be saved to the student if he could but get a bird's-eye view of the contents of the books whose titles he finds so admirably arranged in the index of the well-equipped modern library.

In making use of the magnificent Public Library of Boston I have often felt keenly the discouragement that comes from trying to find certain definite information—in my case usually relating to electrical matters—almost hopelessly concealed by the very wealth of the literature upon the general subject.

I wish, therefore, to lift up my voice—or typewriter—in the warmest support of the plan which was well and clearly set forth by Professor William Townsend Porter, of the Harvard Medical School, in the issue of SCIENCE for September 15, 1899. It contemplates a series of abstracts of books and periodicals devoted to physiology. These abstracts are to be printed upon standard cards, and will therefore take on all the well proved advantages of the card-index system—indeed, the abstracts themselves will constitute a complete card-index, as well as a most valuable bibliography, for the subject in hand. In many cases, moreover, the card abstracts will supply directly the information sought, and so will save much time by forestalling the need of going to the books themselves.

But it would be supererogatory for me to here go into a detailed explanation regarding the system itself. What I do wish to emphasize is the fact that the plan proposed is co-extensive in scope with science itself; and that it is proposed to make a beginning with the science of physiology because the generous interest taken by Professor Porter renders available to the plan a wider view of that subject than of any other, and gives assurance that the abstracts shall be so intelligently edited that the usefulness of the scheme shall have a fair trial.

The plan is laid down in such wise that it can be extended to deal with any other department of scientific knowledge without any change in its general features; and, in my earnest desire to see such a system applied to the literature of electrical science, I am most anxious to see the Physiological Index established. For I am convinced that as soon as a beginning is made which shall familiarize students with the idea, there will be so general an appreciation of the usefulness of the system that its rapid extension to other departments of knowledge will follow as a matter of course.

Science is classified knowledge, and the proposed scheme, as an advance in classification, is a service to science so important that I hope all who are loyal to SCIENCE will manifest such an interest in the proposition that the trustees of the Boston Public Library will have no hesitation in undertaking the publication of the Physiological Index.

PHILIP HENRY WYNNE.

SCIENCE AND SCHOLASTICISM.

PROFESSOR BROOKS' comment, in the current number of SCIENCE, on the remarks made by me concerning his review of Ward's *Naturalism and Agnosticism*, is most suggestive and stimulating. It amounts to a very positive declaration that 'naturalists' (and by this I understand him to imply scientific men in general) must expel all 'abstractions' from their methods and results. No one who has made an impartial effort to appreciate the course of scientific thought—'so-called,' as Brooks would probably say—can fail to assent heartily to this proposition; for, it signifies that the mechanical theory cannot be regarded as a legitimate inference from the evidence assembled by the sciences. So far as I am able to discover, Ward means no more than this. His objections are taken against theories which, though masquerading in the name of science, cannot be ranked as of its household. To be brief, my own complete accord with everything

that Brooks holds has startled me, even although I cannot altogether appreciate his appeal to writers whose thought is still so comparatively medieval as Sir Thomas Browne and Berkeley. The remarks on determinism, for instance, are particularly apposite. If, in my turn, I might dare to speak for contemporary philosophers, I should say, there is no material for controversy, save under that misconception of the situation which Brooks so well lays bare. The crux of our discussion, it may be noted, seems to center in an equivoque as between the precise meaning attached to the term 'naturalism' by Brooks and Ward respectively.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

NOTES ON INORGANIC CHEMISTRY.

AT the sixth annual meeting of the German Electro-chemical Society, held at Göttingen in June, a strong address was delivered by Professor Hittorf on the necessity for the erection of special laboratories and creation of new chairs for inorganic chemistry in the German universities. After alluding to the address before the last meeting of the Society by Van t'-Hoff on the increasing significance of inorganic chemistry, he showed the overwhelming predominance given to organic chemistry in the universities. There are but three German universities where there is any adequate teaching of inorganic chemistry. At all the rest the full professors of chemistry are almost exclusively devoted to the organic field. If Germany is to keep pace in the practical world with England, America and France, a revival of inorganic chemistry is necessary, and for this men and laboratories are needed.

AT the same meeting a new electrical resistance material for high temperature was described by W. C. Heräus. The platinum alloys are not satisfactory owing to their actual low resistance, although their relative resistance is high. The poorest conductor is the 30% iridium platinum alloy, and here the resistance for a meter of wire 0.3 mm. diameter is only 5 ohms. The new resistance material is formed by mixing clay with 10% to 15% of platinum, molding into pencils and heating to about 1250° in a reducing atmosphere. There appears to be formed a platinum silicon alloy which serves as the conductor. The resistance increases with the temperature up to a certain point, and then at higher temperature decreases, perhaps owing to the formation of more platinum-silicon alloy. The pencils can be used up to a red heat and promise to have a very considerable practical application.

SOME time since a specimen of malachite was described by W. Autenrieth which contained an appreciable quantity of iodin. Exhaustive search, however, failed to find any further similar malachites until recently, when a series of malachites and cuprites from New South Wales proved almost without exception to contain iodin. These are described in the *Chemiker-Zeitung*. The amount of iodin in the malachite is 0.15%, and the iodin is given off merely on heating the mineral to low redness. The amount of iodin in the cuprite is less than one-tenth that in the malachite. These minerals were wholly free from silver and bromin, and chlorin was only occasionally present and then in mere traces.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

WEATHER PERIODICITIES.

THE question of periodicities in the weather has received the attention of many meteorologists and physicists; publications on this subject have been numerous and varied; but as yet no sort of general agreement as to, or acceptance of, results has been reached. In this country Clayton has been studying weather periodicities for some years, and his conclusions, although they have not attracted the notice that they deserve, have been noteworthy. In a recent paper entitled *Investigations on Periodicity in the Weather* (Proc. Amer. Acad. Arts and Sciences, XXXIV., No. 22), Clayton carries his investigations a good step farther in advance. Among his results it is shown that there is a small range in the frequency of thunderstorms in the United States, the plotted curves indicating a maximum a few days preceding the greatest northern declination of the moon. A similar result was obtained by Ekholm and Arrhenius for the thunderstorms of Sweden. Further, when the mean daily departures from

the normal temperatures at Blue Hill Observatory from October, 1898, to February, 1899, are plotted, it appears that the minimum temperatures of October, December, January and February occurred very near the times of new moon, the intervals between the minima thus approximating the length of a synodic period of the moon. This paper presents also a summary of a few of the important results reached by European investigators along this same line.

LAKE LEVELS AND PRECIPITATION.

UNDER the title *Variations in Lake Levels and Atmospheric Precipitation*, there has been issued by the Weather Bureau, a report by A. J. Henry, upon the results of a study made by him in connection with the work of the Weather Bureau on the Great Lakes. The conclusions reached are that it seems possible to indicate the level of the Lakes approximately by closely observing the precipitation in the various watersheds, especially the amount of snow and the manner of its disappearance. All inferences as to the probable effect of precipitation on the Lake levels must, however, be contingent upon the maintenance of a constant cross-section and slope in the present connecting channels.

SALT BUSHES IN CALIFORNIA.

SOME interesting experiments have been carried on during the past 18 years at the California Agricultural Experiment Station, in connection with the adaptability of the Australian salt bush to the climate and soils of California. It appears (Univ'y of Cal., Agr. Exp. Sta. Bull. No. 125) that the *atriplex semibaccata* grows on strong alkali soil, furnishing a very large amount of satisfactory pasturage and fodder, and that it also thrives on arid non-alkaline uplands, even where wells have to be sunk 200 feet to water, and where the annual rainfall has been less than five inches. This salt bush cannot endure too heavy summer rains, nor the moist atmosphere of many warm countries, and seems thus singularly well adapted to growing on the deserts and alkaline wastes which are somewhat too common in the southwestern portion of the United States.

R. DEC. WARD.

HARVARD UNIVERSITY.

RECENT ZOOPALEONTOLOGY. 2.

These notes upon recent papers in zoloogy and paleontology will be continued serially.

Triassic Life in Germany.—Under the title, *Die Bildung der germanischen Trias, eine petrogenetische Studie*,* Professor Fraas of Stuttgart, contributes an extremely readable and valuable paper upon the relation between the geography and the fauna during the Triassic period of Germany. This is a model of the best modern mode of treatment in which the geology, geography, zoology and botany of a newly discovered region, are all considered together. It is well shown, that the Trias was preëminently a period in which prominent characters of the great orders of reptiles were fixed. The transition from fresh water to marine conditions by the invasion of the sea, and the corresponding transformation of land and coast forms into free living marine forms is clearly correlated. The changes in the marine and fresh water forms are not only traced in a sketch of the evolution of the invertebrates, but of the vertebrates as well. One suggestion which catches the eye has long been in the mind of the reviewer, namely, that the so-called *Placodontia*, an order of extremely doubtful relations and affinities, known only from the skull, are not at all related to the group of Theriodonts with which they have been placed, but that they represent a branch of the turtles living along the sea coasts, and retaining both in the upper and lower jaw large teeth for the purpose of crushing the shells of small mollusks.

A Triassic Chelonian.—Another very important paper by the same author is upon *Proganochelys Quenstedtii* Baur, a recently discovered example of this Chelonian from the Keuper, or upper triassic rocks of Germany. This is by far the oldest known type of the order. The first remains were apparently discovered in 1863, but not clearly defined until 1887, by Baur. This specimen which was received in the Stuttgart museum in 1897, is far more complete, and enables Professor Fraas to give a description of the dorsal and ventral shields. These show that *Proganochelys* was a true land and swamp dweller, related to the modern

*Separat-Abdruck aus Jahreshefte D. Ver. F. Vaterl. Naturkunde in Württemberg, 1899.

Pluerodira. The structure of this animal is especially interesting and surprising, "since we should expect in such an old representative of the Chelonia, a low stage of development, whereas, this type presents directly the opposite. The Pleurodira are generally regarded as the most specialized and highly developed group of Chelonia, yet this form shows all the characteristics of the family in their most complete development. The uncertainty which surrounds the origin and the evolution of the tortoises, is not therefore removed by this discovery, but on the other hand, is increased."

The Newburgh Mastodon.—The mastodon discovered about two months ago at Newburgh, N. Y., has now been more fully uncovered, but thus far proves to be an incomplete skeleton. The parts preserved are the skull, much injured by removal, both upper tusks, the vertebræ beginning at the last cervical and extending to near the tip of the tail, 18 ribs on each side out of 20, a right scapula and a complete pelvis, and portions of the foot bones. No traces of the limbs have been found thus far, although extensive excavations have been made. Fortunately, Mr. Schaefer, the owner, has removed the bones with care, and treated them skillfully. Many very interesting observations could be made by a careful study and exploration of this locality. During a visit by the present writer, the following observations were made, partly with the aid of Mr. Schaefer. The deposition is in three levels, the two upper being separated by a smooth clearly defined surface, and by slight differences in the character of the soil, which is largely dark and thoroughly decomposed vegetable matter, intermingled with few stones and very numerous remains of trees of various sizes. Examination of the latter gives abundance evidence of the existence of beaver in this hollow in the period of the mastodon, and we can easily imagine, that the different soil levels, were due to the building of successive beaver dams. When the dams were first comple ed the back flow of the water caused temporarily an interruption of the deposition of vegetation and may account for the differences of level above alluded to. The locality has been visited by a large number of people, including several well-known paleontologists. H. F. O.

SOUTH AMERICAN LANGUAGES.

A DILIGENT and careful collecting of quaint and idiomatic words as found in the vernacular dialects is springing up in many countries of America, and there are already a considerable number of printed records of this character. They are made to include also English, French and Spanish words which are evidently of an origin other than European. In many of them the Indian element is well marked, and even in countries where no longer spoken, words of Indian origin are remarkably frequent. Vocabularies and glossaries of this sort were composed by Pichardo for Cuba, by Membreño for Honduras, and the *Journal of American Folklore* contains many articles contributing knowledge for the same purpose. Recently the linguist Samuel A. Lafone Quevedo, M.A., has published "*Tesoro de Catamarqueñismos;* nombres de lugar y esclabones aislados de la lengua Cacana," Buenos Aires, 1898, octavo, pp. 379, a work which adds considerably to our insight into the ethnography of northwestern Argentinia in our century as well as in former periods of history. There may be 3,000 names and vocables of the Catamarca provincial dialects discussed etymologically in Lafone's volume. While some are pure Spanish, others belong to one of the Kechhua dialects, as Amará or Kechhua ; others to Guaicurú dialects, whose domain is in and about the Gran Chaco. Others are supposed to belong to Uro, with main seat in the Bolivian plateaux and studied by Dr. Max Uhle ; and a number are assigned to Cacán, an extinct language which Lafone has long endeavored to reconstruct. It is, however, uncertain, whether Lule (with Tonocoté) or Allentiac, or Chilean dialects are represented in the names and vocables of the collection of this industrious investigator. We must confess, moreover, that a North American finds his way only with immense trouble through the maze of Andean languages and dialects of which not one half has as yet been reduced to grammatic rules.

Another linguistic volume issued in the same year is due also to the efforts of Lafone-Quevedo. This is the publication of a manuscript grammar of the *Toba language*, spoken in the Gran Chaco, along the Paraguay River. It was composed

by the Jesuit Father Alonso Barcena about the year 1600, and at present belongs to the library of General B. Mitre. The Toba is a dialect of the Mocobi-Abipon family of languages, the people having received the name Toba from an artificial enlargement of the forehead. On this account they are also called *Caras* and *Frentones*. The grammar of this rather vocalic idiom is followed by Barcena's Spanish-Toba vocabulary, revised in 1888, with the aid of an Indian called Lopez; the words are accented, but the orthography is rather old-fashioned. The same vocabulary is reproduced again with the Toba word first, followed by the Spanish and the English signification. The volume forms part of the 'Linguistic Library of the Museum of La Plata,' which institution is built close to the city of Buenos Aires; the museum has placed Lafone at the head of its archeological and linguistic department.

Albert S. Gatschet.

Bureau of American Ethnology.

SCIENTIFIC NOTES AND NEWS.

The New York Academy of Sciences opened its sessions on October 2d. The Academy meets in four sections: astronomy and physics, biology, geology and mineralogy, and anthropology and psychology, which meet, respectively, on successive Monday evenings each month until the end of May. In addition to these regular sessions there are five public lectures; a presidential address, this year by Professor Henry F. Osborn, on February 26th; a lecture on psychology on October 30th; one on biology on January 29th; one on geology on March 30th, and one on astronomy and physics on April 30th. Men of science visiting New York are invited to attend the meetings which are held in the rooms of the American Society of Mechanical Engineers, 12 West 31st Street.

The monument erected in memory of Johannes Müller, was unveiled at Coblentz on October 7th.

On October 15th a statue of M. F. Tisserand will be unveiled at Nuits-Saint-Georges.

A statue of John Ericsson, the engineer, who designed the Monitor, has been unveiled at Gothenburg, Sweden.

Sir John Lubbock, Bart, has been appointed a delegate from the London Chamber of Commerce to the International Commercial Congress now meeting in Philadelphia.

We have already referred to the decision of the corporation of the City of Glasgow to appoint a bacteriologist in connection with the Health Department of the City, who would work in conjunction with the medical officer of health and the medical officers of the fever hospitals. The *British Medical Journal* states that there has been considerable competition for this post, and the appointment has just been given to Dr. R. M. Buchanan, a graduate of Glasgow University, who was formerly assistant to the professor of pathology in the University, and more recently professor of medical jurisprudence and public health in Anderson's College. Dr. Buchanan will devote his whole time to his new duties, and will have a suitable laboratory at his disposal in the Sanitary Chambers.

Dr. Arthur Willey has been appointed lecturer on biology in Guy's Hospital.

We learn from the *Educational Times* that Mr. R. P. Paranjpye, the Indian Senior Wrangler, has been awarded a special scholarship of £200 by the Secretary of State, partly as a recognition of his remarkable and distinguished success, and partly to enable him to take the M. A. degree.

It is announced that the date of the opening of the New York Zoological Gardens is fixed for October 25th. At the present time, there have been completed the reptile house, bear dens, flying-cage, prairie dogs' village, aquatic rodents' lake, beaver pool, duck pond, mammal house, burrowing rodents' dens, wolf den, fox den, and buffalo range.

Nature states that the application of the Jenner Institute of Preventive Medicine for permission to alter the memorandum of association so as to enable the Institute to avail itself of Lord Iveagh's gift of 250,000*l.* was granted by Mr. Justice Cozens Hardy on September 13th.

There will be a Civil Service examination in the State of New York, for which applications must be filed not later than October 30th, for an examiner in the commission, requiring a knowledge of steam, electrical and mechanical

engineering with a salary of $1,200 to $1,400 per annum, and for the position of assistant horticulturist in the Geneva experiment station with a salary of $50 per month.

A TELEGRAM has been received at the Harvard College Observatory from Professor Kreutz at Kiel Observatory, stating that Comet E. was observed by Cohn at Königsberg, Oct. 1.2767 Greenwich Mean Time, in R. A. $16^h .31^m 0^s.7$ and December $-4° 39' 50''$. Professor J. E. Keeler at Lick Observatory telegraphs that Comet Giacobini was observed by Perrine, Oct. 2.6658 Greenwich Mean Time, in R. A. $16^h 32^m 59^s.7$ and Dec. $-4°12' 18''$. The check word shows an error in the telegram which will not largely affect the position.

WE learn from *Nature* that the Director of the Marine Observatory of San Fernando announces that the Spanish Minister of Finance has given instructions that all instruments intended for observations of the eclipse of the sun on May 27, 1900, are to be admitted free of duty.

PROFESSOR W. A. SETCHELL, Dr. W. L. Jepson, Mr. L. E. Hunt and Mr. A. A. Lawson, of the University of California have returned to Berkeley from a botanical expedition to Unalaska. Dr. Jepson studied the flowering plants, Professor Setchell and Mr. Lawson the flowerless plants, while Mr. Hunt, who is of the Civil Engineering Department, determined altitudes and took the photographs of plant communities, etc. The party remained at Unalaska for eight weeks and carried out its work as planned, collecting thoroughly in the neighborhood of Unalaska Bay, making extensive field notes, and securing a fairly full collection of photographs. Professor Setchell left Unalaska for about three weeks, on a trip to St. Michael and Cape Nome, collecting plants of all kinds and making notes as to points of distribution and ecology. Returning, the party went from Unalaska to Sitka along the coast, collecting at Unga, Karluk, Kodiak, Orca, Juneau, and Sitka. They were thus able to trace many plants of the shores along a considerable portion of the Alaska coast, note the changes in habit and also the difference in altitudinal distribution. There is a very considerable amount of material accumulated and it will not be known until it is carefully worked over, how much of it is new or just to what extent it will throw light on matters of distribution. A very considerable amount of attention was paid to the matter of plant communities in Unalaska, the amount of woody vegetation present, and a number of such subjects. The lack of trees or even of high shrubs was very noticeable at Unalaska, and in fact along the entire shore of Alaska to the westward, as well as their sudden appearance on the eastern shores of Kadiak Island along North Strait and from there on to the eastward. This seems to be a difficult matter to explain, but it certainly seems to be due to the existence of conditions unfavorable to the germination of the seeds and the growth of seedlings, since trees, when planted or protected during the early stages of existence, thrive on the Island of Unalaska, as several small groves of the White Spruce, whose trees were brought from the Island of Kadiak by the Russians, have not only grown into full sized trees, but also produce cones and seeds. The collections of marine algæ, taken in connection with other collections made in Alaska, Washington and California and Mexico during the last four or five years will, it is hoped, indicate the limits of the various algal floras of the Pacific Coast of North America, when they are properly determined and tabulated, and will afford the basis for some exact inquiry into the causes of demarcation. One of the most gratifying features of the trip was the liberal way in which the U. S. Coast and Geodetic Survey, The Alaska Commercial Company, The Pacific Steam Whaling Company, and the Pacific Coast Steamship Company granted facilities for transportation and collecting.

Nature states that after four months' work on his yacht, Dr. H. C. Sorby, F.R.S., has returned to Sheffield with many hundred specimens of marine animals, preserved by his new methods, so as to show life-like character and natural color.

THE attempt recently made by the U. S. Coast and Geodetic Survey to fix a permanent tidal plane for the Chesapeake Bay has proved successful. During the last fiscal year about

forty stations were occupied, at fifteen of which simultaneous tidal observations extending over one complete lunation were obtained. Mr. E. D. Preston, in the *National Geographic Magazine* for October, summarizes the work done as follows: The average tide for the entire bay is about one foot, possibly less. For Old Point Comfort we have two and one-half feet; for the mouth of the Potomac, one foot; for Washington, three feet; Richmond, three feet; Elk River, at the head of the bay, two feet, and Annapolis less than one foot. The wind effect, however, is sometimes more than the total tide. For example, at Baltimore, the wind effect may amount to three feet, while the tide proper, uninfluenced by local disturbances, is only one-third as much. The small range at Annapolis is due partly to the change in width of the bay, but principally to an interference at this point between the incoming and outgoing tidal waves. When the crest of the southbound movement reaches the mouth of the Severn river it meets the northbound wave from the capes, and a partial neutralization of the vertical motion of the water takes place.

THE International Commercial Congress held in connection with the Export Exposition of the Philadelphia Museums opened on October 12th. Many of the subjects that will be discussed are of scientific interest.

THE Royal Photographic Society is holding its 44th annual exhibition in London this week. There are about 330 exhibits of an artistic character and about 100 of a technical and scientific character. None of the latter, however, represent any important advance.

THE American Public Health Association will hold its annual meeting at Minneapolis, beginning October 31st.

THE second International Congress on Hypnotism will be held in Paris from August 12th to 16th, 1900, under the presidency of Dr. Jules Voisin.

THE Field Columbian Museum, Chicago, has arranged a course of eight lectures on science and travel to be given on Saturdays at three o'clock, as follows:

Oct. 7. 'The Cliff Dwellers of Colorado, Utah, Arizona and New Mexico,' by Mr. E. H. Cooper, Denver, Colo.

Oct. 14. 'Hawaii,' by Mr. R. J. Bennett, Chicago.

Oct. 21. 'A Cruise Among the Antilles—Puerto Rico,' by Dr. C. F. Millspaugh, Curator, Department of Botany, Field Columbian Museum.

Oct. 28. 'A Cruise among the Antilles—Cuba,' by Dr. C. F. Millspaugh, Curator, Department of Botany, Field Columbian Museum.

Nov. 4. 'Some Curious Insects,' by Mr. E. B. Chope, Assistant in Department of Zoology, Field Columbian Museum.

Nov. 11. 'Fishes and Fishing on the Pacific Coast,' by Dr. S. E. Meek, Assistant Curator, Department of Zoology, Field Columbian Museum.

Nov. 18. 'The Katcinas of the Hopi Indians,' by Rev. H. R. Voth, Missionary to the Hopi Indians.

Nov. 25. 'The Eskimo,' by Dr. George A. Dorsey, Curator, Department of Anthropology, Field Columbian Museum.

AN inspector of timber has been created by the Government of the Dominion of Canada. With the view of preserving the remaining forests upon Dominion lands and Indian reserves from destruction by fires and other destructive agencies, and of encouraging the reproduction of forest trees; and also, as settlement is rapidly progressing in all parts of Manitoba and the Northwest Territory, with the object of making an immediate inspection of the country, to ascertain what tracts should be set apart for timber reserves, before they are encroached upon by settlers, the position of Chief Inspector of Timber and Forestry has been created. The headquarters of the inspector will be at Ottawa and his salary will be $2,500 per annum.

A SALISBURY correspondent writes to the London *Times* that the feeling throughout South Wilts is strongly in favor of the Government acquiring Stonehenge at a reasonable price for the nation. At a recent meeting of the Wilton Town Council, it was decided to petition the Government in favor of acquiring the ancient monuments, and the council are calling upon the county authorities and the archeological and antiquarian society to support the petition. Several members of the council questioned very much whether Sir Edmund Antrobus has the power of selling the ground around Stonehenge, which has been open to

the public from time immemorial. There are several roads and footpaths in close proximity to the monument, and the council were unanimous in their opinion that the right of the public to the use of those roads should be maintained. Stonehenge is a source of considerable revenue to Salisbury and district, and the prevailing opinion is that the monument should be acquired by the State.

IN 'Memoires et Compte Rendus des Travaux de la Société des Ingenieurs Civils de France' an extended account is given by M. Chalon of the progress made in that country by 'Metal déployé,' since its introduction from the United States in 1898. The first machine producing Golding's new product was installed in June, 1898, and six are now unequal to the requirements of that country. The process and manufacture are very fully described. The metal used is a steel containing very little C., less than 0.7 per cent Mn., a trace of S. and of Si., and 0.1 per cent. O.

MR. GIFFORD PINCHOT, Forester of the U. S. Department of Agriculture, in the last number of the *National Geographic Magazine*, gives an interesting explanation of the method by which longleaf pine seedlings protect themselves against forest fires. In addition to bark which is not uncommonly as thick as the wood (the whole diameter being thus two-thirds bark and one third wood), the young trees add a device specially adapted for their safety when growing amid long grass, with which they are almost always associated. "During the first four or five years the long leaf seedling reaches a height of but four or five inches above the ground; but while the stem during these early years makes little progress, the long needles shoot up and bend over in a green cascade which falls to the ground in a circle about the seedling. Not only does this barrier of green needles itself burn only with difficulty, but it shades out the grass around the young stem, and so prepares a double fire-resisting shield about the vitals of the young tree.' Such facts explain why the fire which has restricted the growth of evergreen oaks in parts of Florida, for example, has made a pure forest of pines in a region where the reproduction of the oaks is phenomenally rapid wherever the annual fires cannot run."

A PRIZE of 100,000f. has been founded by the heirs of the late Mr. Anthony Pollok, of Washington, to be awarded during the Universal Exhibition which is to be held in Paris in 1900, to the inventor of the best apparatus for the saving of life in case of maritime disaster. The prize is open to universal competition. This sum is now in deposit with the American Security and Trust Company of Washington, D. C., and will be paid over to the successful competitor when a decision shall have been rendered by an appointed jury, and formally communicated to the Secretary of State of the United States, through the Commissioner-General of the United States to the International Exhibition of 1900. The juror selected on behalf of the United States is Lieutenant William S. Sims, U. S. N., Naval Attaché of the Embassy of the United States at Paris. In considering the award the jury will be governed by the following conditions: (1) The total amount of the prize may be awarded to a single individual on condition that the invention is of sufficient practical value and importance to justify the proposed award; (2) should several persons enter inventions of equal value, the jury, as it shall consider right and just, may award a portion of the prize to each; (3) should none of the inventions entered be of sufficient value to entitle it to the prize, the jury may reject any and all of them, but at the same time shall be empowered to indemnify competing inventors in such amounts as may be deemed advisable. The instructions to competitors will be issued in due course by the jury, with the sanction and approval of the authorities of the French Exhibition. These will be distributed upon application. Correspondence, however, may be addressed to the members of the jury at Paris, or to Mr. Charles J. Bell, President of the American Security and Trust Company, No. 1405 G Street, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS.

THE will of Dr. Calvin Ellis, formerly Dean of the Harvard Medical School, has only recently been probated, though his death occurred some years ago. It leaves about $140,000 to

Harvard University. A fund of $50,000 is to be used to defray the expenses of descendants of the family at Harvard College. If not required it is to be spent for the general purposes of the College. The balance of the money is to be used for the Medical School. Miss Lucy Ellis, a sister of Dr. Ellis has now bequeathed about $90,000, the money to be added to the fund left by Dr. Ellis.

PROVOST C. HARRISON, of the University of Pennsylvania, announces a gift of $50,000 from an anonymous donor, the money to be used for the cost of erection of that part of the dormitory system already begun.

BY the will of the late John H. Sessions, $25,000 is bequeathed to Wesleyan University, Middletown, Conn.

THE Iowa Wesleyan University has received a gift of $10,000 from Ex-Senator James Harlan.

THE last session of the Michigan Legislature raised the tax for the support of the State University from one-sixth to one-fourth of a mill of each dollar of assessed valuation, thus increasing the annual income by a little over $92,000.

THE *British Medical Journal* gives the following statistics in regard to the universities of France. These are fifteen in number and together have a total of 27,080 students, of whom 12,059 belong to Paris. The total expenditure is 13,859,500 francs, so that the average cost of the education of each student is 511 francs. To meet this expense the universities have revenues amounting collectively to 2,093,700 francs; legacies, donations, etc., amount to 1,511,600 francs; therefore a deficit of 10,524,200 francs, has each year to be made up by the State.

AMONG the candidates for the Chair of Natural Philosophy in the University of Glasgow are Mr. C. T. R. Wilson, Mr. J. A. M'Clelland and Mr. G. F. C. Searle, all demonstrators in the Cavendish Laboratory, Cambridge; Mr. John Sealy Townsend, Cambridge; Mr. George W. Walker, Cambridge; Professor Andrew Gray, University College, North Wales; Professor J. C. Beattie, Cape Town, and Mr. Cargill Gilston Knott, Edinburgh University.

SINCE Mr. R. M. Wenley, Ph.D. (Glasgow), Sc.D., F.R.S. (Edinburgh), was appointed to the headship of the philosophical department in the University of Michigan, the teaching staff has been doubled and now numbers six. Among recent appointments are Mr. Alfred H. Lloyd, Ph.D. (Harvard), to be junior professor of philosophy; Mr. W. B. Pillsbury, Ph.D. (Cornell), to be director of the Laboratory of Experimental Psychology; Mr. Carl V. Tower, Ph.D. (Cornell), to be instructor in philosophy, and Mr. J. W. Slaughter, A.B. (Lombard), to be assistant in psychology and philosophy.

DR. ALONZO E. TAYLOR, assistant director of the Pepper Laboratory of the University of Pennsylvania, has been elected professor of pathology in the medical department of the University of California.

DR. HENRY S. MONROE, dean of the faculty of applied sciences of Columbia University, has resigned on account of ill health. He is succeeded by Professor F. H. Hutton.

L. F. WALTER and H. Fisher have been appointed assistants in chemistry in Columbia University.

PROFESSOR RICHARD MORRIS, superintendent of public schools in Dunellen, N. J., has been appointed professor of mathematics at Rutger's College.

EZRA F. SCATTERGOOD, instructor in electricity and physics in Rutger's College, has been appointed professor of physics in the Atlanta School of Technology.

VACANCIES in the chemical and electrical departments of the University of Vermont have been filled by the appointment of C. E. Jacobs, of the Massachusetts Institute of Technology, and W. H. Freedman, of Columbia University.

MR. A. G. ASHCROFT has been appointed assistant professor of engineering at the Central College of the City and Guilds of London Institute.

THE Rev. J. F. Cross, B.A. Cambridge, M.A., Toronto, has been made professor of mathematics at St. John's University, Winnipeg.

DR. K. ECKHARDT, professor of physiology at Giessen, has celebrated the fiftieth anniversary of his activity as a university teacher.

SCIENCE

FRIDAY, OCTOBER 20, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REPORT ON PROGRESS IN NON-EUCLIDEAN GEOMETRY.

IT marks an epoch in the history of mathematics that at a meeting of a great Association for the advancement of science there should be presented by invitation a Report on non-Euclidean geometry.

Its two creators, Lobachévski, who misnamed it Imaginary Geometry, and Bolyai János, under the nobler name Science Absolute of Space, failed utterly while they lived, to win any appreciative attention for what is to-day justly honored as one of the profoundest advances of all time. The only recognition, the only praise of the achievement of Lobachévski ever printed in his lifetime was by Bolyai Farkas, the father of his brilliant young rival, and appeared in a little book with no author's name on the title page, and which we have no evidence that Lobachévski ever saw, a little book so rare that my copy is probably the only one on the Western Continent.

When after more than forty years they were rescued from oblivion by Baltzer and Hoüel in 1866, still envious time gave them back only with an aspersion against the genuineness of their originality. A cruel legend tarnished still their fame so long delayed, so splendidly deserved.

Even when their creation had reached the high dignity of being made the subject of courses of lectures for consecutive semesters at the University of Göttingen, yet

on page 175 of the second impression of these lectures, 1893, we still find Felix Klein saying, "Kein Zweifel bestehen kann, dass Lobatscheffsky sowohl wie Bolyai die Fragestellung ihrer Untersuchungen der Gaussischen Anregung verdanken."

It is a privilege to begin my report by announcing the rigorous demonstration that this ungenerous legend is untrue. This point need not further delay us, since it has been treated by me at length in SCIENCE, N. S., Vol. IX., No. 232, pages 813–817, June 9, 1899.

What a contrast to the pathetic neglect of its creators, Lobachévski dying blind, unrecognized, without a single follower, Bolyai János dying of disgust with himself and the world, lies in the fact that less than a year ago our American magazine, the *Monist*, secured from the famous Poincaré, at great cost, a brilliant contribution to this now universally interesting subject, which I had the honor, through my friend T. J. McCormack, of reading in the original French manuscript.

This extraordinary paper, published only in English translation, appears in the *Monist*, Vol. 9, No. 1, Oct., 1898, pages 1–43. In the first section of his greatest work, Lobachévski says: "*Juxtaposition* (contact) is the distinctive characteristic of solids, and they owe to it the name *geometric solids*, when we retain this attribute, taking into consideration no others whether essential or accidental.

"Besides bodies, for example, also time, force, velocity are the object of our judgment; but the idea contained in the word juxtaposition does not apply thereto. In our mind we attribute it only to solids, in speaking of their composition or dissection into parts.

"This simple idea, which we have received directly in nature through the senses, comes from no other and consequently is subject to no further explanation. Two solids A and B, touching one another, form a single geometric solid C, in which each of the component parts A, B appears separate without being lost in the whole C. Inversely, every solid C is divided into two parts A and B by any *section* S.

"By the word section we understand here no new attribute of the solid, but again a juxtaposition, expressing thus the partition of the solid into two juxtaposed parts.

"In this way we can represent to ourselves all solids in nature as parts of a single whole solid which we call space."

Poincaré starts off somewhat differently. He says: "We at once perceive that our sensations vary, that our impressions are subject to change. The laws of these variations were the cause of our creating geometry and the notion of geometrical space.

"Among the changes which our impressions undergo, we distinguish two classes:

"(1) The first are independent of our will and not accompanied by muscular sensations. These are *external changes* so-called.

"(2) The others are voluntary and accompanied by muscular sensations. We may call these *internal changes*.

"We observe next that in certain cases when an external change has modified our impressions, we can, by voluntarily provoking an internal change, re-establish our primitive impressions. The external change, accordingly, can be *corrected* by an internal change. External changes may consequently be subdivided into the two following classes:

"1. Changes which are susceptible of being corrected by an internal change. These are *displacements*.

"2. Changes which are not so susceptible. These are *alterations*. An immovable being would be incapable of making this distinction. *Such a being, therefore, could never create geometry*, even if his sensations were variable, and even if the objects surrounding him were movable."

How like what Lobachévski said more than sixty years before: "We cognize directly in nature only motion, without which the impressions our senses receive are not possible. Consequently, all remaining ideas, for example, geometric, are created artificially by our mind, since they are taken from the properties of motion; and therefore space in itself, for itself alone, does not exist for us."

Poincaré continues: "*the aggregate of displacements is a group.*" At once rise before us the great names Riemann, Helmholtz, Sophus Lie. In fact Poincaré's next section is merely a restatement of part of Riemann's marvellous address, published 1867, on the hypotheses at the basis of geometry.

Again, though the work of Helmholtz did not contain the group idea, yet it had put the problem of non-Euclidean geometry into the very form for the instrument of Sophus Lie, who calls it the Riemann-Helmholtz Space-problem.

To the genius of Helmholtz is due the conception of studying the essential characteristics of a space by a consideration of the movements possible therein.

Felix Klein it was who first called the attention of Lie to this work of Helmholtz, before then unknown to Lie, and pointed out its connection with Lie's Theory of Transformation groups, inciting him to a group-theory investigation of the problem. In 1886 Lie gave briefly his weightiest results in a note: "Bemerkungen zu v. Helmholtz' Arbeit über die Thatsachen, die der Geometrie zu Grunde liegen," in the Berichte of the Saxon Academy, where, in 1890, he gave his completed work in two papers, 'Ueber die Grundlagen der Geometrie' (pp. 284–321, 355–418). The whole investigation published in Volume III. of his 'Theorie der Transformationsgruppen,' 1893, was in 1897 awarded the first Lobachévski Prize. Felix Klein declared that it excels all comparable works so absolutely that a doubt about the award could scarcely be possible. Lie gives two solutions of the problem. In the first he investigates in space a group possessing free mobility in the infinitesimal, in the sense, that if a point and any line-element through it be fixed, continuous motion shall still be possible; but if besides any surface element through the point and line-element be fixed, then shall no continuous motion be possible. The groups in tri-dimensional space possessing in a real point of general position this free mobility, Lie finds to be precisely those characteristic of the Euclidean and two non-Euclidean geometries. Strangely enough, for the seemingly analogous and simpler case of the plane or two-dimensional space these are not the only groups. There are others where the paths of the infinitesimal transformations are spirals. Without the group idea, Helmholtz had reached this reality, and as a consequence concluded that also to characterize our tri-dimensional spaces a new condition, a new axiom, was needed, that of *monodromy*. It is one of the most brilliant results of Lie's second solution of the space problem, that starting from transformation-equations with three of Helmholtz's four assumptions, he proves that the fourth, the famous 'Monodromie des Raumes,' is, in space of three dimensions, wholly superfluous. What a demonstration of the tremendous power of Lie's Group Theory! Lie's method in general, as it appears in the Berichte, is the following:

Consider a tri-dimensional space, in which a point is defined by three quantities x, y, z.

A movement is defined by three equations: $x_1 = f(x, y, z)$; $y_1 = \varphi(x, y, z)$; $z_1 = \psi(x, y, z)$.

By this transformation an assemblage, A, of points (x, y, z) becomes an assemblage, A', of points (x_1, y_1, z_1).

This represents a movement which

changes A to A'. Now make, in regard to the space to be studied, the following assumptions:

(B) In reference to any pair of points which are moved, there is *something* which is left unchanged by the motion. That is, after an assemblage of points, A, has been turned by a single motion into an assemblage of points, A', there is a certain function, Ω, of the coördinates of any pair of the old points (x_1, y_1, z_1), (x_2, y_2, z_2) which equals that same function, Ω, of the corresponding new coördinates (x_1', y_1', z_1'), (x_2', y_2', z_2'); that is
$\Omega(x_1', y_1', z_1', x_2', y_2', z_2') = \Omega(x_1, y_1, z_1, x_2, y_2, z_2)$. This *something* corresponds to the generalized idea of distance interpreted as independent of measurement by superposition of an unchanging sect as unit for length. Moreover assume:

(C) If one point of the assemblage is fixed, every other point of this assemblage, *without any exception*, describes a surface (a two-dimensional aggregate). When two points are fixed, a point in general (exceptions being possible) describes a curve (a one-dimensional aggregate). Finally, if three points are fixed, all are fixed (exceptions being possible). Then Lie proves exhaustively that the group consists either of all motions of Euclidean space or of all motions of non-Euclidean space.

The result is a remarkable one, demonstrating that the group of Euclidean motions and the group of non-Euclidean motions are, in tri-dimensional space, the only groups in which exists in the strict sense of the word free mobility. Thus free motion in the strict meaning of the word can happen in three and only three spaces, namely, the traditional or Euclidean space, and the spaces in which the group of movements possible is the projective group transforming into itself one or the other of the surfaces of the second degree $x^2 + y^2 + z^2 \pm 1 = 0$.

To the fundamental assumption which completely characterizes these three groups, Lie gives also this form:

"If any real point y_1^0, y^0_2, y_3^0 of general position is fixed, then all real points x_1, x_2, x_3, into which may still shift another real point x_1^0, x_2^0, x_3^0, satisfy a real equation of the form:

"$W(y_1^0, y_2^0, y_3^0;\ x_1^0, x_2^0, x_3^0;\ x_1, x_2, x_3) = 0$, which is not fulfilled for $x_1 = y_1^0$, $x_2 = y_2^0$, $x_3 = y_3^0$, and which represents a real surface passing through the point x_1^0, x_2^0, x_3^0.

"About the point y_1^0, y_2^0, y_3^0 may be so demarcated a triply extended region, that on fixing the point y_1^0, y_2^0, y_3^0, every other real point x_1^0, x_2^0, x^0_3 of the region can yet shift continuously into every other real point of the region, which satisfies the equation $W = 0$ and which is joined to the point x_1^0, x_2^0, x_3^0 by an irreducible continuous series of points."

It is a satisfaction to the world of science that Lie's vast achievements were recognized while he lived. Poincaré accepts and expounds his doctrine, saying in the article already mentioned: "The axioms are not analytical judgments *a priori;* they are conventions. * * * Thus our experiences would be equally compatible with the geometry of Euclid and with a geometry of Lobachévski which supposed the curvature of space to be very small. We choose the geometery of Euclid because it is the simplest.

"If our experiences should be considerably different, the geometry of Euclid would no longer suffice to represent them conveniently, and we should choose a different geometry."

When on November 3, 1897, the great Lobachévski prize was awarded to Lie, three other works were given honorable mention. The first of these is a thesis on non-Euclidean geometry by M. L. Gérard, of Lyons. Lovers of the non-Euclidean geometry are naturally purists in geometry, and keenly appreciate Euclid's using solely such

figures as he has rigorously constructed. They understand that problems of construction play an essential part in a scientific system of geometry. Far from being solely, as our popular text-books suppose, practical operations, available for the training of learners, they have in reality, as Helmholtz declares, the force of existential propositions. Therefore is evident the high import of Gérard's work to establish the fundamental propositions of non-Euclidean geometry without hypothetical constructions other than the two assumed by Euclid: 1. Through any two points a straight line can be drawn; 2. A circle may be described from any given point as a center with any given sect as radius. Gérard adds explicitly the two assumptions: 3. A straight line which intersects the perimeter of a polygon in a point other than one of its vertices intersects it again; 4. Two straights, or two circles, or a straight and a circle, intersect if there are points of one on both sides of the other.

Upon these four hypotheses, perfecting a brilliant idea of Battaglini (1867), Gérard establishes the relations between the elements of a triangle.

Lobachévski never explicitly treats the old problems changed by transference into the new geometric world, such as "Through a given point to draw a parallel to a given straight"; nor yet the seemingly impossible problems now in it capable of geometric solution, such as "To draw to one side of an acute angle the perpendicular parallel to the other side"; "To square the circle."

These would be sought in vain in the two quarto volumes of Lobachévski's collected works. Bolyai János, in his all too brief two dozen pages, gives solutions of them startling in their elegance.

But in establishing his theory, he uses, for the sake of conciseness, the principle of continuity even more freely than does Lobachévski.

Gérard, in the second part of his memoir, gives the elements of non-Euclidean analytic geometry, and in the third part, a strict treatment of equivalence.

Even Euclid, in proving his I., 35, "Parallelograms on the same base, and between the same parallels, are equal to one another," does not show that the parallelograms can be divided into pairs of pieces admitting of superposition and coincidence. He uses rather the assumption explicitly set forth by Lobachévski, "Two surfaces are equal when they are sums or differences of congruent pieces." But Creswell in his *Treatise of Geometry*, showed how to cut the parallelograms into parts congruent in pairs. The same can be done for Euclid I., 43, "The complements of the parallelograms, which are about the diagonal of any parallelogram are equal." Hence, we may use the definition: Magnitudes are equivalent, which can be cut into parts congruent in pairs. This method I applied to the ordinary Euclidean geometry in my Elementary Synthetic Geometry before the appearance of Gérard's work, where it is extended to the non-Euclidean.

Regarding the first assured construction of Euclid and Gérard: "A straight line can be drawn through any two points," W. Burnside has given us a charming little paper in the *Proceedings of the London Mathematical Society*, Vol. XXIX., pp. 125–132 (Dec. 9, 1897), enitled 'The Construction of the Straight Line Joining Two Given Points.' Euclid's postulate implies the use of a ruler or straight-edge of any required finite length. The postulate is clearly not intended to apply to the case in which the distance between the two points is infinite. In fact, Euclid I., 31, gives a compass and ruler construction for the line when one of the points can be reached while the other cannot. The other exceptional case when neither point can be reached, *i. e.*, when two given points are the points

at infinity on two non-parallel lines, is not dealt with by Euclid.

In elliptic space any one point can be reached from any other by a finite number of finite operations. The line joining two given points can therefore be always constructed with the ruler alone. In hyperbolic space, if we deal with projective geometry, we must assume that *every* two straight lines in a plane determine a point. When the two straight lines are non-intersectors, the point can neither be a finite point nor a point at infinity. Such a point is termed an 'ideal' point. The problem of constructing the straight line joining two given points involves therefore three further cases; namely, (IV) that in which one of the points is a finite point and the other an ideal point; (V) that in which one is a point at infinity and the other an ideal point; (VI) that in which both points are ideal points.

It is a pleasure to signal the appearance, within the past year, of the second volume of the exceedingly valuable work of Dr. Wilhelm Killing, 'Einführung in die Grundlagen der Geometrie,' (Paderborn, 1898).

With Killing's name will be associated the tremendous difference living geometers find between the properties of a finite region of space, and the laws which pertain to space as a whole. Of the word *direction* he says "it can only be given a meaning when the whole theory of parallels is already presupposed."

The pseudo-proof of the parallel postulate still given in current text-books, for example, by G. C. Edwards in 1895, Killing calls the Thibaut proof, saying that it has especial interest because its originator, who was professor of mathematics at Göttingen with Gauss, published the attempt at a time, 1818, when Gauss had already called attention to the failure of attempts to prove this postulate, and declared that we had not progressed beyond where Euclid was 2000 years before.

But Killing is here in error when he supposes Thibaut the originator of this popular pseudo-proof. It was given in 1813 by Playfair in his edition of Euclid, in a Note to I., 29. It was very elegantly shown to be a fallacy by Colonel T. Perronet Thompson, of Queen's College, Cambridge, in a remarkable book called 'Geometry without Axioms,' of which the third edition is dated 1830, a book seemingly unknown in Germany, since Engel and Staeckel copy from Riccardi the title (with the mistake 'first books' for 'first book') under the date 1833, which is the date of the fourth edition.

Killing has won an important place by investigating the question, what varieties of connection of space are compatible with the different elemental arcs of constant curvature. Riemann, Helmholtz and Lie consider only a region of space, and give analytic expressions for the vicinity of a point. If this region be extended, the question is, what kind of connection of space can result.

Killing shows there are different possibilities, really a series of topologically different forms of space with Euclidean, Lobachévskian, Riemannian geometry in the bounded, simply connected region.

The germinal idea is due to Clifford, who, in an unprinted address before the Bradford meeting of the British Association (1873), 'On a surface of zero curvature and finite extent,' and also by a remark in his paper 'Preliminary sketch of biquaternions,' called attention to a recurrent surface in single elliptic space, which has everywhere zero for measure of curvature, yet is nevertheless of finite area.

Similarly complete universal spaces are found of zero or negative measure of curvature, which nevertheless are only of finite extent. Since there is no way of proving

that the whole of our actual space can be moved in itself in ∞^6 ways, it may possibly be, after all, one of these new Clifford spaces. Free mobility of bodies may only exist while they do not surpass a certain size.

Killing devotes an interesting section, over seven pages, to Legendre's definition of the straight line as the shortest distance between two points. He emphasizes three principle reasons why this is inadmissible. These are (*a*) since the possibility of measurement for all lines is presumed beforehand, which is not allowable; (*b*) since before the execution of the measurement there must be a measuring standard, but this is first given by the straight line; (*c*) since the existence of a minimum is not evident, on the contrary can be demanded only as an assumption.

The first objection was always conclusive, yet it strengthens every day, for our new mathematics knows of lines, real boundaries between two parts of the plane, to which the idea of length is inapplicable.

Under the title 'Universal Algebra,' one would scarcely look for a treatise on non-Euclidean geometry. Yet the first volume of Whitehead's admirable work (Cambridge, 1898, pp. 586) devotes more than 150 pages to an application of Grassmann's Calculus of Extension to hyperbolic, elliptic, parabolic spaces. So devoted is he, that we find him saying: "Any generalization of our space conceptions, which does not at the same time generalize them into the more perfect forms of hyperbolic or elliptic geometry, is of comparatively slight interest." He emphasizes the fact that the three-dimensional space of ordinary experience can never be proved parabolic. "The experience of our senses, which can never attain to measurements of absolute accuracy, although competent to determine that the space-constant of the space of ordinary experience is greater than some large value, yet cannot, from the nature of the case, prove that this space is absolutely Euclidean."

From the many important contributions by Whitehead may be singled out as especially timely his development of a theorem of Bolyai János to which F. S. Macauly called especial attention in the second of his able articles entitled, John Bolyai's 'Science Absolute of Space' (*The Mathematical Gazette,* No. 8, July, 1896, pp. 25–31; No. 9, October, 1896, pp. 49–60). Macauly says, p. 53, "Finally follows a theorem (§ 21), which is, undoubtedly, the most remarkable property of hyperbolic space, that the sum of the angles of any triangle formed by L-lines on an F-surface is equal to two right angles. On this theorem Bolyai remarks: (Halsted's Bolyai, 4th Ed., p. 18), 'From this it is evident that Euclid's Axiom XI., and all things which are claimed in geometry and plain trigonometry hold good *absolutely* in F, L-lines being substituted in place of straights. Therefore, the trigonometric functions are taken here in the same sense (are defined here to to have the same values) as in Σ (as in Euclidean geometry); and the periphery of the circle, of which the L-form radius $= r$ in F, is $= 2\,\pi r$, and likewise the area of circle with radius r (in F) $= \pi r^2$ (by π understanding half the periphery of circle with radius 1 in F, or the known 3.1415926 * * *).'"

Whitehead, in his Universal Algebra, § 262, recurs to this important point, saying: "The idea of a space of one type as a locus in space of another type, and of dimensions higher by one, is due partly to J. Bolyai, and partly to Beltrami. Bolyai points out that the relations between lines formed by great circles on a two-dimensional limit-surface are the same as those of straight lines in a Euclidean plane of two dimensions. Beltrami proves by the use of the pseudosphere, that a hyperbolic space of any number of dimensions can be considered as a locus in Euclidean space of

higher dimensions. There is an error, popular even among mathematicians, misled by a useful technical phraseology, that Euclidean space is in a special sense flat, and that this flatness is exemplified by the possibility of a Euclidean space containing surfaces with the properties of hyperbolic and elliptic spaces. But the text shows that this relation of hyperbolic to Euclidean space can be inverted. Thus no theory of the flatness of Euclidean space can be founded on it." Whitehead has since followed up his point in a very important and powerful paper in the *Proceedings of the London Mathematical Society*, Vol. XXIX., pp. 275–324, March 10, 1898, entitled 'The Geodesic Geometry of Surfaces in non-Euclidean Space.' He there says, "The relations between the properties of geodesics on surfaces and non-Euclidean geometry, as far as they have hitherto been investigated, to my knowledge, are as follows:

"It has been proved by Beltrami that the 'geodesic geometry' of surfaces of constant curvature in *Euclidean* space is the same as the geometry of straight lines in planes in elliptic or in hyperbolic space, according as the curvature of the surface is positive or negative.

"The geometry of great circles on a sphere of radius ρ in elliptic space of 'space-constant' γ is the same as the geometry of straight lines in planes in elliptic space of space-constant $\gamma \sin \frac{\rho}{\gamma}$.

"The geometry of great circles on a sphere of radius ρ in hyperbolic space of 'space-constant' γ is the same as the geometry of straight lines in planes in elliptic space of space-constant $\gamma \sin \mathrm{h} \frac{\rho}{\gamma}$.

"The geometry of geodesics (that is, lines of equal distance), on a surface of equal distance, σ, from a plane in hyperbolic space of space-constant γ, is the same as that of straight lines in planes in hyperbolic space of space-constant $\gamma \cos \mathrm{h} \frac{\sigma}{\gamma}$.

"Finally, the geometry of geodesics (that is, limit-lines), on a limit surface in hyperbolic space—which may be conceived either as a sphere of infinite radius or as a surface of equal, but infinite, distance from a plane —is the same as that of straight lines in planes in Euclidean space.

"The preceding propositions are due directly, or almost directly to John Bolyai, though, of course, he only directly treats of hyperbolic space.

"From the popularization of Beltrami's results by Helmholtz, and from the unfortunate adoption of the name 'radius of space curvature' for γ (here called the space-constant), many philosophers, and, it may be suspected from their language, many mathematicians, have been misled into the belief that some peculiar property of flatness is to be ascribed to Euclidean space, in that planes of other sorts of space can be represented as surfaces in it. This idea is sufficiently refuted, at least as regards hyperbolic space, by Bolyai's theorem respecting the geodesic geometry of limit surfaces. For a Euclidean plane can thereby be represented by a surface in hyperbolic space.

"It is the object of this paper to extend and complete Bolyai's theorem by investigating the properties of the general class of surfaces in any non-Euclidean space, elliptic or hyperbolic, which are such that their geodesic geometry is that of straight lines in a Euclidean plane.

"Such surfaces are proved to be real in elliptic as well as in hyperbolic space, and their general equations are found for the case when they are surfaces of revolution.

"In hyperbolic space, Bolyai's limit-surfaces are shown to be a particular case of such surfaces of revolution. The surfaces

fall into two main types; the limit surfaces form a transition case between these types. In elliptic space there is only one type of such a surface of revolution.

"The same principles would enable the problem to be solved of the discovery in any kind of space of surfaces with their 'geodesic' geometry identical with that of planes in any other kind of space."

So that which Macauly designated as 'undoubtedly the most remarkable property of hyperbolic space' has been by Whitehead not only generalized for hyperbolic space but extended to elliptic space.

Bolyai János seemed fully to realize the weight, the scope, the possibilities, the meaning of his discovery. He returns to it in § 37, where he uses the proportionality of similar triangles in F to solve an essential problem in S (hyperbolic space). Then he adds: "Hence, easily appears (L-lines being given by their *extremities alone*) also fourth and mean *terms* of a proportion can be found, and all geometric constructions which are made in Σ in plano, in this mode can be accomplished in F *apart from Axiom XI*." The italics are Bolyai's, yet I find that they have not been reproduced in my published translation (the only one in English), nor in Frischauf's German, nor in Hoüel's French, nor in Fr. Schmidt's Latin text, nor in Suták's Magyar. Whitehead's researches will remind us all how great a thing it was to have reached the whole Euclidean system entirely apart from any parallel-postulate. It is a pleasure to be able to state that this was also done by Lobachévski. It is explicitly given in his first published work 'O nachalah geometri' (1829). 'Noviya nachala geometri' (1835), devotes to it Chapter VIII.

It is also at this point, so striking as pure mathematics, that general philosophy finds itself involved. Killing, Klein, and in general the German writers, distinctly draw back from any philosophical implications. The whole matter, however, has been opened in 'An Essay on the Foundations of Geometry,' by Hon. Bertrand A. W. Russell, Fellow of Trinity College, Cambridge (1897), who has had the good fortune to be the very first to set forth the philosophical importance of von Staudt's pure projective geometry, which in its foundation and dealing with the qualitative properties of space involves no reference to quantity. I discussed this point more than twenty years ago in the *Popular Science Monthly*, *à propos* of Spencer's classification of the Abstract Sciences.

In a note to the first edition of his classification of the sciences (omitted in the second edition), Spencer says, "I was ignorant of this as a separate division of mathematics, until it was described to me by Mr. Hirst. It was only when seeking to affiliate and define 'Descriptive Geometry' that I reached the conclusion that there is a negatively-quantitative mathematics as well as a positively-quantitative mathematics." As explanatory of what he wishes to mean by negatively-quantitative, we quote from his Table I.: "Laws of Relations, that are Quantitative (Mathematics), Negatively: the terms of the relations being definitely-related sets of positions in space, and the facts predicted being the absence of certain quantities ('Geometry of Position')." He also says: "In explanation of the term 'negatively-quantitative,' it will be sufficient to instance the proposition that certain three lines will meet in a point, as a negatively-quantitative proposition, since it asserts the absence of any quantity of space between their intersections. Similarly, the assertion that certain three points would always fall in a straight line is 'negatively-quantitative,' since the conception of a straight line implies the negation of any lateral quantity or deviation." But Sylvester has said of this very proposition

that it "refers solely to position, and neither invokes nor involves the idea of quantity or magnitude."

"Projective Geometry proper," says Russell, "does not employ the conception of magnitude."

Now it is in metrical properties alone that non-Euclidean and Euclidean spaces differ. The distinction between Euclidean and non-Euclidean geometries, so important in metrical investigations, disappears in projective geometry proper. Therefore projective geometry deals with a wider conception, a conception which includes both, and neglects the attributes in which they differ. This conception Mr. Russell calls 'a form of externality.' It follows that the assumptions of projective geometry must be the simplest expression of the indispensable requisites of all geometrical reasoning.

Any two points uniquely determine a line, *the straight*. But any two points and their straight are, in pure projective geometry, utterly indistinguishable from any other point pair and their straight. It is of the essence of *metric* geometry that two points shall completely determine a spatial *quantity, the sect* (German, strecke). If Mr. Russell had used for this fundamental spatial magnitude this name, or any name but 'distance,' his exposition would have gained wonderfully in clearness. It is a misfortune to use the already overworked and often misused word 'distance' as a confounding and confusing designation for a sect itself and also the measure of that sect, whether by superposition, ordinary ratio, indeterminate as depending on the choice of a unit; or by projective metrics, indeterminate as depending on the fixing of the two points to be taken as constant in the varying cross ratios.

That Mr. Russell's chapter 'A Short History of Metageometry,' contains all the stock errors in particularly irritating form, and some others peculiarly grotesque, I have pointed out in extenso, in SCIENCE, Vol. VI., pp. 478–491. Nevertheless the book is epoch-making. It finds "that projective geometry, which has no reference to quantity, is necessarily true of any form of externality. In metrical geometry is an empirical element, arising out of the alternatives of Euclidean and non-Euclidean space."

One of the most pleasing aspects of the universal permanent progress in all things non-Euclidean is the making accessible of the original masterpieces.

The marvellous '*Tentamen*' of Bolyai Farkas, as Appendix to which the 'Science Absolute' of Bolyai János appeared, a book so rare that except my own two copies, I know of no copy on the Western Continent, a book which has never been translated, a field which has lain fallow for sixty-five years, is now being re-issued in sumptuous quarto form by the Hungarian Academy of Sciences. The first volume appeared in 1897, edited, with sixty-three pages of notes in Latin, by König and Réthy of Budapest. Professor Réthy, whom I had the pleasure of meeting in Kolozsvár, tells me the second volume is in press, and he is working on it this summer.

Bolyai Farkas is the forerunner of Helmholtz, Riemann, Lie, though one would scarcely expect it from the poetic exaltation with which he begins his great work. "Lectori salutem! Scarce superficially imbued with the rudiments of first principles, of my own accord, without any other end, but led by internal thirst for truth, seeking its very fount, as yet a beardless youth, I laid the foundations of this 'Tentamen.'

"Only fundamental principles is it proposed here so to present, that Tyros, to whom it is not given to cross on light wings the abyss, and, pure spirits, glad of no original, to be borne up in airs scarce respirable, may, proceeding with firmer step, attain to the heights.

"You may have pronounced this a thankless task, since lofty genius, above the windings of the valleys, steps by the Alpine peaks; but truly everywhere are present gordian knots needing swords of giants. Nor for these was this written.

"Forsooth I wish the youth by my example warned, lest having attacked the labor of six thousand years, alone, they wear away life in seeking now what long ago was found. Gratefully learn first what predecessors teach, and after forethought build. Whatever of good comes, is antecedent term of an infinite series."

His analysis of space starts with the principle of continuity: spatium est quantitas, est continuum (p. 442). This Euclid had used unconsciously, or at least without specific mention; Riemann and Helmholtz consciously. Second comes what he calls the *axiom of congruence*, p. 444, § 3, "corpus idem in alio quoque loco videnti, quæstio succurrit: *num loca ejusdem diversa æqualia sint?* Intuitus ostendit, æqualia esse."

Riemann: "Setzt man voraus, dass die Körper unabhängig von Ort existieren, so ist das Krümmungsmass überall constant." See also the second hypothesis of Helmholtz.

Third, any point may be moved into any other; the free mobility of rigid bodies. If any point remains at rest any region in which it is may be moved about it in innumerable ways, and so that any point other than the one at rest may recur. If two points are fixed, motion is still possible in a specific way. Three fixed points not costraight prevent all motion (p. 446, § 5).

Thus we have the third assumption of Helmholtz, combined with his celebrated principle of Monodromy.

Bolyai Farkas deduces from these assumptions not only Euclid but the non-Euclidean systems of his son János, referring to the approximate measurements of astronomy as showing that the parallel postulate is not sufficiently in error to interfere with practice (p. 489). This is just what Riemann and Helmholtz afterward did, only by casting off also the assumption of the infinity of space they got also as a possibility for the universe an elliptic geometry, the existence of a case of which independently of parallels was first proven by Bolyai János when he proved spherics independent of Euclid's assumption. So if Sophus Lie had ever seen the 'Tentamen,' he might have called his great investigation the Bolyai-Farkas Space Problem instead of the Riemann-Helmholtz Space Problem.

The first volume of the 'Tentamen' as issued by the Hungarian Academy does not contain the famous appendix. But in 1897, Franz Schmidt, that heroic figure, ever the bridge between János and the world, issued at Budapest, the Latin text of the Science Absolute, with a biography of Bolyai János in Magyar, and a Magyar translation of the text by Suták József.

Strangely enough, though the Appendix had been translated into German, French, Italian, English, and even appeared in Japan, yet no Hungarian rendering had ever appeared. It was Franz Schmidt who placed the monument over the forgotten grave of János, only identified because there still lived a woman who had loved him. Now in this Magyar edition he rears a second monument. The introduction by Suták is particularly able.

The Russians have honored themselves by the great Lobachévski Prize; why does not that glorious race, the Magyars, do tardy justice to their own genius in a great Bolyai Prize?

One other noble thing the Hungarian Academy of Science has just achieved, the publication in splendid quarto form of the correspondence between Gauss and Bolyai Farkas: (Briefwechsel zwischen Carl Friedrich Gauss und Wolfgang Bolyai). It was again Franz Schmidt who, after long en-

deavors, at last obtained this correspondence from the Royal Society of Sciences at Göttingen, where Bolyai had sent the letters of Gauss at his death. The Correspondence is fitly edited by Schmidt and Staeckel. It gives us a romance of pure science. Gauss was the greater mathematician; Bolyai the nobler soul and truer friend. On April 10, 1816, Bolyai wrote to Gauss giving a detailed account of his son János, then fourteen years old; and unfolding a plan to send János in two years to Göttingen, to study under Gauss. He asks if Gauss will take János into his house, of course for the usual remuneration, and what János shall study meanwhile. Gauss never answered this beautiful and pregnant letter, and never wrote again for sixteen years! Had Gauss answered that letter Göttingen might now perhaps have to boast a greater than Gauss, for in sheer genius, in magnificent nerve, Bolyai János was unsurpassable, as absolute as his science of space. But instead, he joined the Austrian army, and the mighty genius which should have enriched the transactions of the greatest of learned societies with discovery after discovery in accelerating quickness, preyed instead upon itself, printing nothing but a brief two dozen pages.

Almost to accident the world owes the admirable volumes in which Staekel and Engel contribute such priceless treasures to the non-Euclidean geometry. An Italian Jesuit, P. Manganotti, discovered that one of his order, the Italian Jesuit Saccheri, had already in 1733 published a series of theorems which the world had been ascribing to Bolyai. Thereupon, in 1889, E. Beltrami published in the *Atti della Reale Accademia dei Lincei,* Serie 4, Vol. V., pp. 441–448, a note entitled 'Un Precursore italiano di Legendre e di Lobatschewski,' giving extracts from Saccheri's book which abundantly proved the claim of Manganotti.

In the same year, 1889, E. d'Ovidio, in the *Torino Atti*, XXIV., pp. 512–513, called attention to this note in another entitled, Cenno sulla Nota del prof. E. Beltrami: "Un Precursore, etc.," expressing the wish that P. Manganotti would by a more ample discussion rescue Saccheri's work from unmerited oblivion. Staeckel says the thought then came to him, whether Saccheri's work were not a link in a chain of evolution, the genesis of the non-Euclidean geometry.

In 1893, at the International Mathematical Congress at Chicago, in the discussion which followed my lecture, 'Some Salient Points in the History of Non-Euclidean and Hyper-Spaces,' wherein I gave an account of Saccheri with description of his book and extracts from it, Professor Klein, who had never before heard of Saccheri, and Professor Study, of Marburg, mentioned that there had recently been brought to light an old paper of Lambert's anticipating in points the non-Euclidean geometry, and named in connection therewith Dr. Staeckel. I at once wrote to him and published in the *Bulletin of the New York Math. Soc.*, Vol. III., pp. 79–80, 1893, a note on Lambert's non-Euclidean geometry, mentioning Staeckel's purpose to republish Lambert's paper in the Abhandlungen of the Leipziger Gesellschaft der Wissenschaften. But after this, in January, 1894, Staeckel formed the plan to make of Saccheri and Lambert a book, and associating with him his friend Friedrich Engel, they gave the world in 1895, 'Die Theorie der Parallellinien, eine Urkundensammlung zur Vorgeschichte der nichteuklidischen Geometric.' Strengthened by the universal success of this book, they planned two volumes in continuation. Staeckel takes the volume devoted to Bolyai János and his father. It is to begin with a more complete life of the two than has yet appeared, of course from material furnished largely by Franz Schmidt.

Then follows the 'Theoria parallelarum'

of Bolyai Farkas, interesting as proving that in 1804 Gauss was still under the spell of Euclid.

Then is to follow the Latin text of the immortal Appendix with a German translation. Next comes in German translation selections from the 'Tentamen.' The book concludes with the geometric part of 'Kurzer Grundriss,' the only one of the Bolyai's works printed originally in German. This volume is nearly published and may be expected in a few weeks. The volume undertaken by Engel has just appeared (1899). It is a German translation of Lobachévski's first published paper (1829), 'On the Principles of Geometry,' and also of his greatest work, 'New Elements of Geometry, with Complete Theory of Parallels.' Only from the 'New Elements' can any adequate idea be obtained of the height, the breadth, the depth of Lobachévski's achievement in the new universe of his own creation.

Of equal importance is the fact that Engel's book gives to the world at last a complete, available text-book of non-Euclidean geometry. There is no other to compare with it.

For the history of non-Euclidean geometry we have the admirable Chapter X., of Loria's pregnant work, 'Il passato ed il presente delle principali teorie geometriche.' This chapter cites about 80 authors, mostly of writings devoted to non-Euclidean geometry.

In my own 'Bibliography of hyper-space and non-Euclidean geometry,' in the *American Journal of Mathematics* (1878), I gave 81 authors and 174 titles. This, when reprinted in the Collected Works of Lobachévski (Kazan, 1886), gives 124 authors and 272 titles.

Roberto Bonola has just given in the *Bollettino di Bibliografia e Storia della Scienze Matematiche* (1899), an exceedingly rich and valuable 'Bibliografia sui Fondamenti della Geometria in relazione alla Geometria Non-Euclidea,' in which he gives 353 titles.

This extraordinary output of human thought has henceforth to be reckoned with. Hereafter no one may neglect it who attempts to treat of fundamentals in geometry or philosophy.

GEORGE BRUCE HALSTED.

AUSTIN, TEXAS, Aug. 14, 1899.

BOTANY AT THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION 'G' was attended by a large number of Botanists and the meeting was in every way pleasurable and profitable.

On Monday afternoon Charles R. Barnes gave the vice-presidential address in Botanical Hall of the Ohio State University, to a large and appreciative audience. His theme was the 'Progress and Problems in Vegetable Physiology,' and the address has been published in full in SCIENCE.

During each of the succeeding four days, two sessions were held and thirty-three papers were read and discussed. Wednesday was made a Memorial Day to Sullivant and Lesquereux; the exercises are described below by Mrs. Britton.

Among the items of business transacted by Section 'G' may be mentioned that which related to the publication of the card index of American Botany, and an expression of high appreciation of the appointment of an eminent physiological chemist in the Division of Vegetable Pathology and Physiology, United States Department of Agriculture.

The authors of papers and an outline of the more important points are herewith presented:

'The Fertilization of Albugo bliti,' by F. L. Stevens, Chicago, Ill.

The paper presented the results of two year's research on the development of the

sex organs and the act of fertilization which, in this species, differs from the current conception of a fertilization in that the oösphere is a compound one, having about one hundred functional nuclei: each one of these fuses with one male pronucleus derived from the antheridium. The development of these nuclei and the organs that bear them is followed and the mitoses described, as is also the opening of the antheridial tube and the fusion of the nuclei. A new cell organ, present during the oögenesis, the *cœnocentrum*, is described, and the ripening of the oöspore followed.

'The Embyro Sac of Leucocrinum montanum,' by Francis Ramaley, Boulder, Colorado.

The embryo sac of Leucocrinum is of the usual Liliaceous type. The sac is never greatly elongated but generally rather spherical. The polar nuclei fuse before the fecundation of the egg. The definitive nucleus moves from the center of the sac toward the posterior end before any division takes place. The synergids are large: they persist for a short time after the fecundation of the egg. The antipodal cells do not increase in number but a fragmentation of the nuclei sometimes occurs. The antipodals do not become completely disorganized for a long time, and may still be recognized after a considerable mass of endosperm has been built up and the sac completely filled. The author found nothing to suggest a fusion between the definitive nucleus and a male cell.

'Notes on Subterranean Organs,' by A. S. Hitchcock, Manhattan, Kansas.

A classification of the underground parts of perennial plants, especially the herbs, is made as below: accompanied also by notes and examples:

Roots which form adventitious buds;
Fleshy roots with a crown at apex:
Crown with top-root—with fibrous roots;
Rhizomes; simple, crown-bearing.

Various subdivisions of each of the above, with examples were given. The notes referred to plants in the vicinity of Manhattan, Kansas, confined chiefly to dicotyledons.

'Some Monstrosities in Spikelets of *Eragrostis* and *Setaria* with their Meaning,' by W. J. Beal, Agricultural College, Michigan.

A few plants of *Eragrostis major* made a second growth of some of the spikelets—more than twice the usual length, in a damp late autumn. A few spikes of *Setaria viridis* in same autumn had bristles bearing spikelets at the top, and one with a spikelet on the side of a bristle.

'Studies of the Vegetation of the High Nebraska Plains,' by Charles Edwin Bessey, Lincoln, Nebraska.

The physical conditions on the high plains of Western Nebraska include a general elevation of 1000 to 1200 meters above sea level, a rainfall of but 40 centimeters per year, a very high insulation, a sandy soil, with a generally undulating surface, with now and then a shallow moist valley. Until recently these plains were swept annually with prairie fires. The ecological conditions are taken up for the Box Butte plains where the grassy covering is an Agropyron-Stipa-Bouteloua formation; for the Snake Creek valley, with a Sporobolus formation, surrounded by a zone of Distichlis; for the undulating surface with its exclusive Carex formation; for rocky hills with a broad zone of Artemisia in one line capped with a zone of Mentzelia; for the river bottom (Platte) with its Distichlis-Atriplex-Chenopodium.

'The Tamarack Swamp in Ohio,' by A. D. Selby, Wooster, Ohio.

A preliminary study of the Larix plant company as occurring in Ohio. The location of these bogs in the northeast counties extending as far south as Canton, and in the extreme northwest of Ohio, was pointed out; and a preliminary list of 36 species collected

in these swamps by the author and E. W. Vickers, of Ellsworth, Ohio, was presented in summary form. The rarest of these are of the genera *Sarracenia*, *Drosera*, *Trientalis*, *Salix*, *Arethusa*, *Coptis*, *Chiogenes*, *Ilicioides*, *Cornus* (*C. Canadensis*) and species of *Vibúrnum*.

'The Breeding of Fruits for the Northwest Plains,' by Wm. Saunders, Ottawa, Canada.

The author refers to the many failures which have followed the testing of a large number of the hardiest forms of useful apples on the northwest plains. These failures have led to the belief that the most hopeful line of work in future is the improvement of two species of Wild Crabs from Northern Siberia, viz.: *Pyrus baccata* and *P. prunifolia*, both of which have been tested and found quite hardy, but are quite small. These have been crossed with hardy forms of the larger apples and some of the particulars of the results obtained from these crosses were presented.

'Field Experiments with 'Nitragin' and other Germ Fertilizers,' by Byron D. Halsted, New Brunswick.

The study of leguminous root tubercles is uppermost in the minds of botanists and there is a practical side that deeply interests the crop growers. It has been shown that the microscopic symbionts greatly assist in the acquiring of nitrogen by the plants with which they live.

Professors Knobbe and Hiltner, of Tharand, Saxony, foremost in the study of the symbiotic germs, have produced pure cultures and these are placed upon the market as bottled lymph under the trade name of 'Nitragin.' Experiments are now in progress at the New Jersey Experiment Station, and some of the results are as follows:

The germs from five species, namely, *Vicia sativa*, *V. villosa*, *Trifolium pratense*, *T. repens* and *T. incarnatum* were used, each in separate rows and upon the seeds of all five of the above named legumes. Plants were lifted August 3d and the tubercles counted upon five plants and the average taken. It was found that the tubercles were more numerous upon the check plants than where the 'Nitragin' had been used, and it seems evident, judging from the number of galls, that the germ fertilizer has had no appreciable effect.

A duplicate of the above trial was made upon soil where peas had been grown for four successive crops. Here the only difference to be noted was the large increase in the number of tubercles, those of the old pea land being nearly double those upon the new land.

A still more extended experiment was made with thirteen leguminous crops from land that had been variously treated in previous years with soil remedies for club root in turnips. It was found that sulphur and lime both materially diminished the number of tubercles.

An equal area was given to a test of the germ fertilizer offered through the trade under the name of 'Alinit' and recommended for crops generally. The actual weight of five leguminous crops and four cereals (one failed) showed a grand total in favor of the check, although the difference was only slight.

Experiments with several other substances that might be supposed to stimulate the development of germs in the soil indicate that they have no wholesome influence.

'The Duration of Bacterial Existence under Trial Environments,' by Henry L. Bolley, Agricultural College, N. D.

The paper is based upon studies made from ordinary cultures which had been preserved for a number of years. Many had been allowed to become air dried, suffering the varying conditions of the laboratory atmosphere. Other cultures had been hermetically sealed and thus kept in fresh form.

The results are of interest because of the longevity shown for many of the germs; and because of the indicated possibility of keeping typical cultures in normal form as to gross characters and as to the morphology of the individual germs for long periods of time.

'Suggestion for a more Satisfactory Classification of the Pleurocarpous Mosses,' by A. J. Grout, Brooklyn, N. Y.

It is axiomatic that the classification of plants having an alternation of generations should be based on both gametophyte and sporophyte character. Schimper and nearly all modern authors except Lindberg and Braithwaite give undue weight to sporophyte characters, as in the *Isotheciæ*, where a heterogeneous collection of plants is put in the same subfamily because of their sporophyte character alone. Lindberg while classifying more scientifically often overestimates single characters, *e. g.*, when he puts *Porotrichum* (*Thamnium*) with the Neckeraceæ because of its leaf character, all its other characters indicating a close relationship to the Hypneæ.

There are two characters of the pleurocarpous mosses whose importance in classification is generally underestimated: the presence or absence of a central strand in the stem and, the presence and degree of development of fine transverse lines on the lower dorsal plates of the teeth of the peristome. The latter are present and well developed in the subfamilies Hypneæ and Brachytheciæ. Also in the genera *Isothecium*, *Porotrichum*, *Pterogonium* and *Leseura*, which are closely related and constitute a separate subfamily differing from the above mentioned subfamilies in leaf structure.

These lines are as well developed in Thuidium and allied genera of the Leskeaceæ (as usually constituted) as in the Hypneæ and taken in connection with the perfect Hypnaceous peristome indicates that these forms are at least as closely related to the Hypneæ as to the Leskeaceæ. In the latter family these lines are vestigial and the whole peristome degenerate so that Thuidium must either be an intermediate form or a separate derivative from the Hypnaceous type. The presence of a perfect peristome with these lines well developed in the Pterygophyllaceæ indicates that this family is closely related to the Hypneæ.

The entire absence of these lines in the Fontinalaceæ, Neckeraceæ, and Climacium taken in connection with other characters indicates that these forms constitute a group by themselves, coördinate with the forms previously mentioned and possibly derived independently from the acrocarpous mosses. The anomalies of the Fabroniaceæ may possibly indicate a third similar group.

The central strand is the physiological homologue of the vascular bundle and for many reasons would seem to be of a far more important character than the length and shape of the capsule, yet in our present system it is given far less weight. The presence of a central strand is usually correlated with the presence of a costa in the leaves except in aquatic or subaquatic species. This indicates that *Amblystegium* and *Plagiothecium* are not naturally grouped and must also modify the present systems in many cases.

The author wishes it distinctly understood that the above statements are thrown out as suggestions, because his knowledge of forms is far too incomplete to warrant any final statements.

'Notes Concerning the Study of Lichen Distribution in the Upper Mississippi Valley,' by Bruce Fink, Fayette, Iowa.

A brief report of area covered, data as to habitat, etc., and a list of species examined. The author pointed out the incompleteness of recorded observations and suggested the noting of fuller data in connection with the collection of specimens.

'Botanical Teaching in Secondary Schools.'

Under this head three papers were read, the authors being W. C. Stevens, Lawrence, Kansas; Ida Clendenin, Brooklyn High School, and Conway MacMillan, Minneapolis, Minn.

The paper of Mr. Stevens forcibly pointed out serious defects in much of the so-called botanical teaching, and argued for a study of plants rather than text-books merely.

Miss Clendenin maintained that biological studies were important factors in mental development of children, and that they should not be postponed till late in the school curricula. It was immaterial whether zoology or botany was taken up first, but that at least an entire school year—four or five lessons weekly—should be given to them. In addition to this the last year in the course should offer one or both of these branches as optional studies. As to whether the work should be largely microscopical, dealing fully with the cell and tissues, commencing with the lowest plants and closing with the representatives of the highest groups; or rather making morphology and physiology prominent in the course, dealing mostly with specimens and material obtainable by the pupils and using the microscope only for demonstration; is determined mainly by the environments in which the teacher finds himself (large classes, excessive work in the school room, etc.): there is no alternative for the great majority, and the second scheme must be followed.

Miss Clendenin rightly insisted that it offered as good disciplinary and practical work as the first, and that the finer methods of the modern laboratory of histology should be left to the Universities, where alone their practice was possible.

Professor MacMillan's paper can not be condensed and therefore, it is here presented as it was read to the Section:

I.

Introduction:

(*a*) Education is essentially a social function, hence the school is a social organ. The work of the school must therefore be criticised not by the individual aptitude or abilities of the graduates, but by the intellectual and moral condition of the community in which the school has been active.

Sociology, not psychology, is the scientific foundation of a true system of pedagogics.

(*b*) Society is an organism with moving equilibrium, always progressive or decadent. Progress of individuals is not incompatible with social retrogression.

It is stated that homicides are on the increase in the United States. In the light of the figures it may well be asked, does education educate?

(*c*) What are the fundamental difficulties with the schools? clearly the same as with any complex organ derived by a process of evolution: *There are too many vestigial characters.*

Educational methods arise to meet the exigencies of particular epochs, nations or localities. After these epochs are past, nations extinct or localities abandoned, the methods do not likewise disappear but remain petrified in the traditions of the schools, to be worn away by the slow attrition of the ages.

Nevertheless, while I am in favor of educational museums, I regret that our public schools should ever be such institutions.

(*d*) The modern tendency in school ciricula is to introduce everything new as a concession to the radicals, and to keep everything old as a concession to the conservatives. But education is not pursued by the race either for the exploitation of pedagogical theories, or for the perpetuation of traditions belonging to a by-gone civilization.

The real practical problem is not what to put into the cirriculum, but what to take out. This deserves the most thoughtful consideration. We are sometimes told that

there are so many demands upon the high school pupil that little space is left for biological science.

II.

(*a*) The object of the high school education is not culture but *capability*, not individuality but *organizability*, not consciousness but *conscientiousness*, not well-rounded men and women but *well-adjusted* men and women.

Therefore, education must always have a double content (1) information, developing the structure of the social individual, (2) training exercise in social functioning.

(*b*) A general classification may be made of subjects in the cirriculum, under these views.

1. Technique of life: Reading, writing, spelling, mathematical calculation, etiquette, hygiene, manual training and drawing, local geography, modern languages, logic.

2. Conditions of life: Chemistry, physics, physiography, geology, civil government. (Physiology.)

3. Principles of life: Psychology, economics, ethics, sociology.

4. Epitomes of life: History, biology, literature, art, music.

5. Vestigial subjects: Ancient languages, metaphysics.

(*c*) Such a classification is necessarily very elastic. Certain phases of biology are seen to be properly included under each of the classifications.

(*d*) In general the value of biological instruction lies not in the information, but in the training. This training is without a rival in the curriculum for the following reasons:

1. The organisms studied, whether plants or animals, are microcosms revealing to the student, under conditions free from prejudice, the laws and factors of man and of society.

2. As compared with history or literature which are likewise epitomes of life, biology has the advantage of thorough organization under the modern scientific method. The subject itself may be considered as a record: it differs, however, from history in being a record not so much impregnated with human error, and from literature in being free from the personal element. Furthermore, the method of reading the record is fresh, and devoid of those older unscientific blemishes which prevent us from interpreting either history or literature apart from prejudice.

3. The quality of insight is developed under conditions that are more impartial than in the study of history or literature. For example, there is a secular and even a profane history—but there is neither secular or profane biology. There is national, religious, political, personal literature, but there is no national, no religious, no political, no personal biology.

4. The quality of judgment, under such conditions, must be more perfectly and completely developed than under any other.

Observation, classification, recollection, orderly notation, etc., can be inculcated as well by other disciplines. Note A. T. Harris' comparison of botany with grammar.

III.

What should be the nature of High School courses in Biology.

(*a*) In the first place courses in elementary general biology are impracticable because (1) either an inherently superficial view of both plants and animals, or (2) a one-sided view of the living world must be presented. Further, there is no possible way of instituting just comparisons between plants and animals in the time given to elementary study. Consequently, the idea of 'general biology courses' is founded on pedagogical error.

(*b*) Courses must be in 'botany and zoology,' or 'botany or zoology.'

(*c*) A year of either biological science should include more anatomy and physiology than taxonomy, although the latter must not be neglected.

(*d*) I favor a year of botany followed by a year of zoology, in the High School course.

IV.

Methods: (Not presented).

'On the Occurrence of the Black Rot of Cabbage in Europe,' by H. A. Harding, Geneva, N. Y.

During the season of 1898 this disease was observed by the author, on cabbage and related plants in fields near Haarlem in Holland, Bonn, Karlsrule, Fulda, Berlin, Halle on Saale and Kiel in Germany, Slagelse in Denmark, Zurich in Switzerland and Versailles in France.

Wherever an opportunity to visit fields presented itself the disease was always found, although with the exception of Switzerland and possibly Denmark, it did not appear to be of economic importance.

Field observations were supplemented whenever possible by microscopic and cultural examinations.

Sections of infested plant parts presented the same characters as is shown by the disease common in America.

Cultures uniformly produced a predominant growth of yellow colonies, agreeing in general appearance and in morphology with *B. campestris* Pam.

Subcultures were brought to New York and inoculated into cabbage and cauliflower. In the case of germs obtained from Zurich, Switzerland, the inoculation invariably produced a disease exactly like that found common in our fields, and behaved in all respects like cultures obtained from diseased plants in Wisconsin and New York.

With germs brought from other plants in Europe the results were not so conclusive.

'A Thousand Miles for a Fern,' by Charles Edwin Bessey.

The Southern Maiden-hair Fern (*Adiantum capillus-veneris*) was found August 24, 1898, in the Black Hills of South Dakota. It grows in the warm streams (25° C.), which issue from numerous large springs. The species is indigenous.

'A Summary of our Knowledge of the Fig with Recent Observations,' by Walter T. Swingle, Washington, D. C.

A summary of the existing knowledge concerning the fig, caprifig and caprification, including the results of recent observations by the author in North Africa, Greece and Asia Minor.

This paper is published in full below.

'The Classification of Botanical Publications,' by William Trelease, St. Louis, Mo.

This article will appear in full in a later number.

'The Geotropism of the Hypocotyl of *Cucurbita*,' by Edwin Bingham Copeland.

Experiments show that the plant executes the geotropic response without direct regard to the consequences, and without the power of adaption to unusual conditions. In nature the rapid growth of the under side of a prostrate hypocotyl bears the cotyledons upward: but if a young plant be placed horizontal with the cotyledons fast and the roots free, the same response bears the roots upward, and is therefore likely to be immediately fatal. While the object of geotropism is to secure a certain arrangement of the longitudinal elements for the plant—root, hypocotyl, cotyledons—the stimulus is a disturbance of the normal disposition of the transverse pressure of the tissues. It is not necessary for the perception of a geotropic stimulus that the plant compare the difference in position or pressure of its two halves; for if the plant is laid prostrate, the lower half will of itself grow more rapidly than the upper, as may be demonstrated by cutting the halves entirely apart.

'The Destruction of Chlorophyll by Oxidizing Enzymes,' by A. F. Woods, Washington, D. C.

This paper details the results of experiments going to show that the Mosaic disease of tobacco is due to oxidizing enzymes rather than to a 'living fluid contagium' as suggested by Beijerinck. It also shows that these enzymes are unusually abundant in many other cases of variegation, and in the disease known as peach yellows and peach rosette; and in these cases also ascribes the destruction of the chlorophyll to the abnormal abundance of these ferments.

'The Effect of Hydrocyanic Acid Gas upon the Germination of Seeds,' by C. O. Townsend, College Park, Md.

In the experiments that form the basis of this paper, seeds in both the dry and damp state have been tested with different strength of gas and for different periods of time. In the case of dry grains and seeds it was found that they might remain for several weeks in an atmosphere of hydrocyanic acid gas, many times as strong as is required for the almost instantaneous destruction of insect life, without appreciably injuring their germinating power. Indeed the gas under these conditions slightly accelerates germination, and the subsequent rate of growth of the seedlings is slightly above the normal.

Seeds that have been soaked in water become very sensitive to the presence of hydrocyanic acid gas. If the seeds have been soaked for twenty-four hours they cannot germinate if more than 0.030 of a grain of potassium-cyanide per cubic foot is used in generating the gas. Even 0.003 of a grain of potassium-cyanide per cubic foot has a very marked effect on the time of germination of seeds that have been soaked in water for twenty-four hours. If the grains and seeds have been soaked but six hours, they are more resistant than when soaked for a longer period; but even under these circumstances germination is distinctly retarded by the pressure of hydrocynic acid gas.

'Some Physiological Effects of Hydrocyanic Acid Gas Upon Plants,' by W. G. Johnson, College Park, Md.

A brief report of the first precise experiments with hydrocyanic acid gas upon young fruit trees, both dormant and in full foliage.

'Etiolative Reactions of Sarracenia and Oxalis,' by Wm. B. Stewart, Minneapolis, Minn.

An anatomical examination of etiolated leaves of Sarracenia and Oxalis, shows the increase of length of supporting tissues by increase in size and multiplication of cells, and the new development of portions which functionate in light only.

Etiolative reactions are almost purely adaptive in their nature.

'The Mycorhiza of Tipularia,' by Julia B. Clifford, Minneapolis, Minn.

The roots tipularia show some marked specializations of structure for adjustment, for the presence of an endotropic fungus with which a symbiosis is formed. The fungus is differentiated into a vegetative mycelium, with external absorbent branches and internal branches serving as organs of interchange.

'Cultures of Uredineæ in 1899,' J. C. Arthur, Lafayette, Ind.

Successful cultures of eleven species of Uredineæ were made upon their host plants, showing the connection of æcidial and teleutosporic stages. The following is a list of the associated forms, the host plants, and nature of the cultures:

1. *Puccinia Convolvulus* Cast. on *Convolvulus sepium*, and *Æcidium Calystegiae* Desm. on same host, with sowings of teleutospores.

2. *Puccinia Phragmitis* (Schum.) Koern. on *Phragmites communis* Trin. and *Æcidium rubellum* Pers. on *Rumex crispus* L. and *R. obtusifolius* L. with sowings of teleutospores.

3. *Puccinia Americana* Lagh. on *Andropogon sco-*

parius Mx. and *Æcidium Pentstemonis* Schw. on *Pentstemon pubescens* Sol. with sowings of æcidiospores and teleutospores.

4. *Puccinia Windsoriæ* Schw. on *Triodia cuprea* Jacq. and *Æcidium Pteleæ* B. & C. on *Ptelea trifoliata* L. with sowings of æcidiospores.

5. *Puccininia Vilfæ* A. & H. on *Sporobolus asper* (Mx.) Kunth. and *Æcidium verbenicola* K. & S., with sowings of æcidiospores.

6. *Puccinia peridermiospora* (E. & T.) Arth. on *Spartina cynosuroides* (L.) Willd, and *Æcidium Fraxini* Schw. on *Fraxinus viridis* Mx. with sowings of teleutospores.

7. *Puccinia Caricis* (Schum.) Reb. on *Carex stricta* Lam. and *Æcidium Urticæ* Schum. on *Urtica gracilis* Ait., with sowings of æcidiospores.

8. *Puccinia angustata* Ph. on *Scirpus atrovirens* Muhl. and *Æcidium Lycopi* Ger. on *Lycopus sinuatus* Ell., with sowings of æcidiospores.

9. *Uromyces Euphorbiæ* C. & P. on *Euphorbia nutans* Lag. and *Æcidium Euphorbiæ* Am. Auct. on same host, with sowings of æcidiospores.

10. *Phragmidium speciosum* Fr. on *Rosa humilis* Marsh. and *Cæoma miniata* Am. Auct. on *Rosa sp.* with sowings of teleutospores.

11. *Triphragmium Ulmariæ*—on *Ulmaria rubra* Hill and *Cæoma Ulmariæ*—on same host, with sowings of æcidiospores and uredospores.

'The Embryology of Vaillantia Hispida,' by Francis E. Lloyd, New York.

The archesporium consists of about twelve cells. But one of the megaspores produced therefrom normally becomes the embryo-sac, the development of which follows in much the usual fashion, in a position, however, removed from the archesporium ; this position is attained by a migration of the megaspore involved out of the nucellus into the micropylar canal. Fusion of the polar nuclei takes place at some distance from the egg ; toward which, however, the endosperm moves and to which it ultimately becomes closely applied. The antipodals are three, one of which is very long, one end being plunged into the disintegrating archesporium, which is believed to serve as food. The embryo has a suspensor which forms outgrowths into the endosperm, these acting as food absorbing organs. The endosperm enlarges at the expense of the integument which has the appearance of a tissue undergoing digestion. A part of the integument remains as a seed envelope. The reserve food consists of cellulose and starch.

'The Division of the Megaspore of Erythronium,' by John H. Schaffner, Columbus, Ohio.

Our knowledge of the process of reduction is still very fragmentary and the observations and interpretations presented by the several investigators differ widely. *Erythronium albidum* and *E. americanum* present favorable objects for the study of the important phenomena which take place during the transition from the sporophyte to the gametophyte. As in the case of the lilies generally, the megaspore of *Erythronium* arises from the archesporial cell, directly, by differentiation and not by division. The archesporial cell can usually be distinguished before the first of October and it continues to develop until after the first of December, when it passes into a partial resting stage and does not complete its division until early the next Spring. The cell, therefore, in which the reduction takes place, has a period of development extending over six months.

In the Fall while the nucleus is expanding, the chromatin net-work begins to thicken until a continuous band is formed. In the Spring the band twists itself up into twelve loops, which break apart and form twelve very large, coiled chromosomes. The chromatin granules never appear very distinct and they do not begin to divide until the chromatin band begins to form the loops. After the pseudo-reduction the chromosomes are arranged on the spindle threads with their closed ends turned outward and are then gradually untwisted and pulled apart at the middle. This results in the transverse division of each chromosome, one transverse half going to each daughter nucleus.

The division of the megaspore of *Ery-*

thronium is, therefore, essentially the same as in *Lilium philadelphicum*, and it seems to the writer that a transverse, qualitative division is the only interpretation possible.

'The Flora of Franklin County, Ohio,' by A. D. Selby, Wooster, Ohio.

A comparison of the known flora of Columbus, Ohio, with that listed in the catalogue of Wm. S. Sullivant in 1840, in tabular form. It shows a gain of the known list amounting to 353 species; of which 117 are introduced; in other words, 184 species of the present known flora, or 167 per cent. of the present, are of introduced species.

'The Fungus Infestation of Agricultural Soils in the United States,' by Erwin F. Smith, Washington, D. C.

A continuation of studies begun by the writer in 1894 on the parasitic soil *Fusaria* of the United States. Results are detailed of completed experiments on soil infections with the watermelon fungus, over 500 of which have been obtained. It shows that related species are likely to prove equally destructive to plants of other families, *e. g.*, cabbage, tomato, sweetpotato. The fact to be specially emphasized is that these fungi live in the soil over winter and attack the plant from the earth. Further, the soil once infected with one of these resistant fungi becomes worthless for growing the agricultural plants subject to it for a long series of years, and consequently the greatest care should be taken to avoid the spread of these parasites to land which is now free from them.

'Are the Trees Advancing or Retreating Upon the Nebraska Plains'? by Charles Ewing Bessey.

To appear in full later.

'Useful Trees and Shrubs for the Northwest Plains of Canada,' by Wm. Saunders, Ottawa, Canada.

In this paper is given the results of a large number of experiments conducted during the past eleven years in testing the hardiness and usefulness of many species and varieties of trees and shrubs, both native and foreign, on the Canadian experimental farms in Manitoba and the northwest territories. Some particulars are given as to the success which has attended this work and attention called to some of the groups to which the hardiest forms belong. References are also made to many individual species and varieties which have been found most useful.

'The Occurrence of Calcium Oxalate and Lignin during the Differentiation of the Buds of *Prunus Americana*,' by H. L. Bolley and L. R. Waldron, Agricultural College, N. D.

The paper consists of a short *résumé* of the occurrences of crystals of calcium oxalate and of the presence of lignified tissues, as observed by Mr. Lawrence Waldron in a study conducted upon the development of life history of the buds of *Prunus Americana*. It was found that the crystals of calcium oxalate occur in quite surprising abundance in the meristematic tissues of the bud and in the very youngest stages of the scales of the bud; and that the oxalate becomes lessened in proportionate quantity as the tissues develop. Lignification of the hairs and scales of the bud commences at a very early period of their development. While it is usually assumed that calcium oxalate is a waste product of metabolism, its occurrence in such large quantities in the meristematic cells of the bud and scales would seem to indicate a question as to whether it has a definite value at this point, at this particular time, in the life history of the plant.

'Two Diseases of *Juniperus*,' by Herman Von Schrenk, St. Louis, Mo.

The species of *Juniperus* are trees which have few fungous and insect enemies. The author describes two destructive diseases of *Juniperus Virginiana*, one of which is also found in *Juniperus Bermudiana* and *Thuya*

occidentalis. The first one is due to an undescribed species of *Polyporus.* Large holes are formed in the heartwood of the trunk, one above the other. Each is full of mycelium and has a thick white lining, consisting of wood fibers from which the lignin has been removed, leaving the pure cellulose. The fruiting part forms on the outside of the trunk, forming around a dead branch. It has been reported so far from Kentucky and Tennessee. The second form of destruction is more widely spread. It is due to a *Polyporus,* probably *P. carneus.* Long pockets are formed in the heartwood of a tree, filled with a brown bitter wood, which has characteristic properties. The sporophore forms in the branch holes on the trunk; they have a flesh-colored hymenium and are quite common.

Attention is called to the fact that a very large per cent. of the individuals of *Juniperus Virginiana* are defective because of one or other of these fungi.

'The Crystals in *Datura Stramonium* L.', by Henry Kraemer, Philadelphia.

An exhaustive paper which will be published in full in the *Journal of Pharmacy.*

W. A. KELLERMAN,
Secretary of Section G.
OHIO STATE UNIVERSITY.

SULLIVANT DAY.

WEDNESDAY, August 23d, was taken by the Botanical Section for a bryological memorial to do honor to Sullivant and Lesquereux. The meeting was held in the Botanical Lecture Room which had been appropriately decorated with mosses and ferns and hung with portraits of Sullivant and Lesquereux loaned by the members of both families present. The tables surrounding the room were filled with books and pamphlets on bryological subjects, and the spaces under the windows with microscopes showing rare or type specimens of mosses and hepatics. The walls were hung with photographs of botanists whose names are associated with American bryophytes, as well as plates and illustrations from original publications.

The meeting was called to order with Dr. Chas. R. Barnes in the chair and Professor Kellerman as Secretary, who welcomed the large number of members and guests present and opened the session with some preliminary remarks on the work done on the flora of Ohio by Joseph Sullivant, William S. Sullivant, Riddell and others, and exhibited pressed specimens, framed of *Sullivantia Ohionis, Lonicera Sullivantii, Solidago Ohionis, S. Riddellii,* and other rare plants. Duplicates of these were distributed in sets after the adjournment of the session. Professor Kellerman then read Dr. Gray's tribute to Sullivant from the Supplement to the Icones. Twelve North American mosses have been named for Sullivant; specimens of these with original drawings were loaned from the Sullivant collection in the Gray Herbarium at Harvard University; duplicates of these species were presented by the Herbarium of Columbia University to the Ohio State University and microscopic slides were made by Mrs. Britton who gave a short account of them.

Dr. Barnes then read a brief biographical sketch of Leo Lesquereux, exhibiting the picture of his father's home at Fluellen where he fell down a mountain in search of plants, one of the causes of his subsequent deafness, a misfortune which in the end proved a blessing, as it enabled him to devote himself with undisturbed serenity to the study of fossil plants and mosses. Several of his paleontological works were not published until after his death and many of the illustrations were made by his granddaughter, Miss Ahrhart, who acted as his interpreter and assistant. A brief account of these posthumous publications was pre-

pared by Dr. Arthur Hollick, and presented by Professor D. T. MacDougal.

Mrs. Britton gave a chronological record of the study of N. A. bryophytes since 1850, with tabulated lists of publications and exsiccatæ, illustrating more particularly with books and pamphlets the progress of the study of the mosses since the publication of Lesquereux' and James' Manual in 1884. Professor Kellerman showed a collection of mosses formerly the property of A. Schrader who made the drawings for Sullivant's Icones. Most of the specimens are European, collected or presented by Lesquereux, but there a few duplicate types of North American species accompanied by plates, among them the originals of Sullivant's species from the Survey of the 35th parallel. The collection was presented to the Ohio State University by Dr. Townshend.

Professor Underwood gave a brief account of the progress of the study of the Hepaticæ, exhibiting his own publications and those of W. H. Pearson, A. W. Evans and M. A. Howe, and a set of plates from the last volume of the Memoirs of the Torrey Botanical Club, containing the enumeration of Californian Hepaticæ and Anthocerotaceæ. Twelve new species were figured by Dr. Howe, the originals of which were exhibited for him by Professor F. E. Lloyd, who commended the morphological value of his work.

An attempt was made to secure reports from all North American bryologists. This was only partially successful, as many were away and unable to be present. Dr. Barnes showed a set of the publications of Renauld and Cardot from the *Botanical Gazette* and of Roll from Hedwigia. Dr. George N. Best sent a set of his reprints and an abstract of his work. Dr. A. J. Grout sent a set of the Bryologist and his Revisions of some genera of pleurocarpous mosses with suggestions for a more satisfactory classification. Dr. Charles Mohr sent some notes on the moss-flora of Alabama, which were read by Professor F. S. Earle. Mrs. Britton exhibited a set of maps with regions marked where mosses have been collected, and lists of stations and collectors, compiled with the assistance of Dr. J. K. Small. Reports were received from the Sullivant Moss Chapter through its secretary, Mrs. Annie M. Smith, with a list of members and of the mosses named by Sullivant. The Philadelphia moss-chapter also made a report through its secretary, Mr. Mc. Elwee, with lists of the collections and publications available for studying the mosses at the Philadelphia Academy of Natural Sciences.

At the conclusion of the exercises, Dr. C. E. Bessey spoke of the desirability of founding a bryological scholarship to be named for William S. Sullivant. This proposition was heartily commended by the chairman and the various members of the Sullivant family present. During the remainder of the day the exhibits were open to inspection and duplicate specimens of *Orthotrichum Ohioense* were distributed.

Elizabeth G. Britton.

SECTION D (ZOOLOGY) AT THE DOVER MEETING OF THE BRITISH ASSOCIATION.

The president of this Section was Mr. Adam Sedgwick, of Cambridge, and his address dealt with such fundamental questions as reproduction, variation and heredity. He considers that one of the most important results of the evolutionary change has been the gradual increase and perfection of heredity as a function of organisms and a gradual elimination of variability. This would enable evolution to be effected much more rapidly in early periods than at present, and so may enable us to bring our requirements as to time within the limits granted by the physicists.

As some of the other Sections were to receive addresses of general biological interest,

it was arranged that Section D should adjourn after Mr. Sedgwick's address until the following morning. The scheme of work for the remaining days was this: Friday morning, morphological papers; Friday afternoon, entomology and some reports; Saturday, marine biology and reports; Monday, morphology, embryology, etc.; Tuesday, sea-fishery papers and discussions.

Amongst the morphological papers on Friday were:

1. Mr. J. Lister (Cambridge), 'On *Astrosclera willeyana*,' the type of a new family of Calcareous sponges. This remarkable new form was collected by Dr. A. Willey in the Loyalty Islands. Its abundant calcareous polyhedral spicules fuse to form a continuous branched skeleton. The ciliated chambers in the canal system are very minute, and the ciliated cells have no collars round the flagella.

2. Professor S. Symington (Belfast), 'On the Morphology of the Cartilage of the Monotreme Larynx.' The author considers that both the ontogeny and phylogeny of the mammalian epiglottis support the view that it is a single median structure, and not as Gegenbaur supposed the result of fusion of two lateral elements.

3. N. Bishop Harman (Cambridge), 'The Palpebral and Oculomotor Apparatus in Fishes.' Seventy species were examined. The degree of complexity was not found to agree with the probable phylogeny, or with the scheme of classification. The source of the complex musculature of the eyelids of Selachii was traced to the branchial musculature of the spiracle, and this was also exemplified by the inverse ratio existing between the condition of the spiracle and the nictitating membrane. In those fish in which the latter shows its highest development the spiracle is absent and *vice versa*.

The condition of the orbital sac of a supporting rod of cartilage in the eyes of many cartilaginous fishes, of the ligament in relation to the optic nerve in many bony fishes, and of the eye muscles and other neighboring structures, was discussed in the various groups and some species of fishes. The special condition of the obliquus superior in pleuronectids and in some mammals indicates the possibility of independent evolution of organs in widely severed types along similar lines when the conditions of use are similar. This paper will be published *in extenso* in the *Journal of Anatomy and Physiology.*

4. Several minor papers and reports were also taken.

On Saturday, when some of the zoologists from the French Association, then meeting at Boulogne, visited the Section, a few papers on Marine Biology likely to prove interesting for joint discussion were read. Mr. W. Garstang gave a report upon his periodic investigation of the plankton and physical conditions of the English Channel during 1899. They were carried out at quarterly intervals from a steamer along certain fixed lines from Plymouth to Ushant, then out to the 100 fathom line, and back to Plymouth across the mouth of English Channel. Serial observations were taken of the water temperatures of the salinity and of the contained fauna and flora. At first the plankton was collected by means of a pump and hose, but this proved unsatisfactory, and so Mr. Garstang devised a closing townet which is a modification and signification of Giesbrecht's. This new net and also that of Dr. C. G. Joh. Petersen, of Copenhagen, were on exhibition in the Section, and were also shown working in the sea to a party of zoologists on board Mr. Woodall's yacht one afternoon during the meeting. In the discussion that followed, Baron Jules de Guerne discussed the somewhat similar net he had been using on board the Prince of Monaco's yacht, *Princesse Alice.*

Reports upon the work done by holders

of the British Association tables at the Naples and Plymouth biological stations were then submitted.

On Monday the chief papers were:

1. J. S. Kerr, 'The Development of *Lepidosiren paradoxa*,' and a note on the hypothesis of the origin of the vertebrate paired limbs.

2. J. F. Gemmill, 'On Negative Evidence regarding the Influence of Nutrition in Determining Sex.' Dr. Gemmill deals with marine animals fixed in such a position that some individuals get more food than others. This seems to cause no difference in the proportions between the sexes.

3. F. P. Morena and A. Smith Woodward, 'Exhibition of Skull of Extinct Chelonian *Miolania*, and of newly-discovered *Neomylodon* remains from Patagonia,' with remarks.

4. G. E. H. Barrett Hamilton, 'The Fur Seals of Behring Sea.'

On Tuesday Sir John Murray read a paper on Dr. Petersen's experiments on plaice culture in the Limfjord, Denmark. Outside the fjord the plaice are found abundant, but small. When transplanted into the richer feeding ground they rapidly grow larger, and can be sold at such a price that it may be regarded as successful economic fish culture.

Mr. W. Garstang then gave an account of his experiments at Plymouth in rearing young sea-fish. He has used the Butterfly Blenny, kept in 'plunger' jars, not more than five larvæ to a gallon of water, and fed on plankton. The experiments have been very successful, about 50% of the larvæ being reared through the metamorphosis to young adults. Professor McIntosh finally had a paper on the occurrence of the grey gurnard (*Trigla gurnardus*) and its spawning in shore and off shore waters. He shows by a monthly examination of the statistics that this important fish does not begin to migrate in shore for spawning purposes until March, and attains its maximum in May. He does not consider that there is a second spawning migration later (August), as stated by the Fishing Board for Scotland. The spawning extends from April to September.

The reports of the committees to the sections were:

1. Naples Zoological Station, with report by Dr. Jameson on his work at Cephyrea.

2. Plymouth Biological Station, with papers on the embryology of *Polyzoa*, by T. H. Taylor, and on rearing of *Echinid* larvæ, by Professor MacBride.

3. Zoology and Botany of West India Islands, Final Report, with list of publications.

4. Zoology of Sandwich Islands, Exploration and publication both in progress.

5. Bird Migration in Great Britain and Ireland, Records now being worked out.

6. Zoological and Botanical Publication, Committee on Correspondence with Editors.

7. Index Animalium, First section (1758–1800) nearly ready for publication.

8. Pedigree Stock Records, Reliable Records by Photography of Pedigree Stock.

9. Circulatory Apparatus for Marine Organisms, Record of Color Changes in Crustacea.

Most of these committees were reappointed, with grants, for the coming year.

W. A. Herdman.

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*THE DIŒCISM OF THE FIG IN ITS BEARING UPON CAPRIFICATION.**

As is well known, the edible fruit of the fig is morphologically an enlarged, hollow, flowering branch, bearing within the nearly closed cavity thousands of minute flowers. It is therefore not a true fruit in a botanical sense, but a fleshy receptacle.

Two crops of figs are usually produced during the year; first, the *figues fleurs*, or *brebas*, which appear in March or April,

*Read before Section G of the American Association for the Advancement of Science at Columbus.

and the ordinary figs, appearing on the new wood of the year, after the *brebas* mature, in June or July, and ripening in August or September. This second crop may be irregular in season, some Italian sorts not maturing all their fruits until Christmas (the 'Natalino') or Easter (the 'Pasquale'). In both crops of figs the flowers are exclusively female, though always malformed in the *brebas*, according to Gasparrini and Solms-Laubach, and sometimes in the second generation, according to Dr. Eisen. The flowers in the *brebas* are never pollinated, and indeed no pollen is to be had at the season when they develop. The ordinary figs may be fecundated by pollen from the caprifig, and the sorts which produce the dried figs of commerce are regularly so pollinated by the fig insect (*Blastophaga*), and in consequence yield fertile seeds in abundance. These figs of the so-called Smyrna type often absolutely require pollination in order to set a crop while the ordinary sorts esteemed for eating in the fresh condition develop without the inclosed flowers having been pollinated, but lack the peculiar nutty flavor communicated to the dried fig by the presence of the fertile seeds, a fact to which attention was first called by Dr. Eisen.

THE CAPRIFIG.

The caprifig is even more complicated in its fruiting than is the ordinary fig. There are three generations of fruits, usually known by their Neapolitan names. I. The *mamme*, or caprifigs of the winter generation, which set about October and ripen from March to May, usually in April. II. The spring generation, called *profichi*, setting when the *mamme* fall, and ripening in June or July. This is the generation for caprification. III. The summer generation, *mammoni*, which set shortly after the *profichi* fall and ripen when the *mamme* set. All three generations harbor the fig insect, *Blastophaga psenes*,* which lives inside the ovaries, converting the seed into a gall. When the female insects enter the young caprifigs after leaving the ripe caprifigs of the previous generation, they lay one egg in each of the gall flowers, which are then very like female flowers but not identical, having imperfect stigmas. The *profichi* or spring generation caprifigs bear abundant male flowers in a zone occupying the upper part of the fig, just below the mouth. It is this generation, abounding in pollen, which is used in caprification. It is worthy of note that male flowers mature *nearly two months* after the gall flowers are ready to receive the eggs of the insect, and only just before the figs ripen; *e. g.*, *mammoni* female flowers, which occur though rarely, are pollinated by *profichi* pollen, the rare *mammoni* male flowers not developing until two months later. The *mammoni* or summer generation produce a few male flowers in the same position, and the *mamme* or winter generation none, or only a few imperfect flowers. The *mamme* and *profichi* never produce seeds; the *mammoni* a very few only.

There are two or three exceptions to the normal noted above. As in most diœcious species, monœcious forms of figs occur, though rarely. There are, for example, male flowers occasionally produced in cultivated figs, and on the other hand, there are nearly always a very few female flowers

**Blastophaga psenes* of Cavolini, perhaps not of Linnaeus whose *Cynips psenes* was based on the account of Hasselquist, edited by Linnaeus, and published in 1757, and included Hasselquist's two species, *Cynips ficus* and *Cynips caricæ*. Both these species were described as '*Corpus totum rufum*,' and, as Mayer points out in opposition to Loew, can scarcely apply to *Blastophaga*. Hasselquist's names having been published before 1758, the earliest available descriptions of indubitable application to the fig insect and its common messmate are, respectively, *Ichneumon psenes* and *Ichneumon ficarius* of Cavolini, published in 1782, the latter of which should be known as *Philotrypesis ficaria* (Cavolini).

in the summer generation of caprifigs (*mammoni*), although Count Solms-Laubach found only twenty seeds in forty *mammoni*. Perhaps one flower in 2,000 is female, the others being gall flowers.

Then, too, there is a fig, called Erinosyche, which according to Pontedera bears *profichi* like a caprifig, and then a summer generation of ordinary edible figs; also the Croisic fig of Brittany and the Cordelia fig of California, which have a zone of male flowers above the ordinary edible part. This upper portion of the fig, bearing the male flowers, remains tough and inedible. Such abnormalities have, however, many analogies in other groups of plants, and do not obscure the fact that the edible fig is, as Hegardt contended in 1744, the female form, and the caprifig the male form of a diœcious species. The remarkable feature of the fig is that its male receptacles bear gall flowers which are only slightly modified female flowers, and that these gall flowers harbor insects which pollinate the female fig flowers, and lay eggs in succeeding generations of caprifigs. The symbiosis is doubtless one of the oldest known, all of the hundreds of species of figs being inhabited by insects of a special family, Agaonidæ, which are all remarkably adapted to their peculiar habitat, while the figs appear as if specially constructed to nourish and protect the insects on which they are completely dependent for pollination. Both the insects and the plants are much more profoundly modified than are, for example, the Yucca and its moth, Pronuba.

CAPRIFICATION.

Herodotus (484–408 B. C.) seems to have known caprification, and Aristotle about 340 B. C., gave a perfectly clear account of it as follows:* "The figs of the caprifig contain small animals which are called *psenes.* These are at first small grubs, and when their envelopes are broken, *psenes* which fly come out; they then enter the fruits of the fig tree; and the punctures which they make there prevent these fruits from falling before they are ripe. So the countrymen take the trouble to put branches of the caprifig in the ordinary fig trees, and also plant caprifigs near the common fig trees." Theophrastus, his pupil, gave a more extended account, and for the first time noted that not all sorts of figs needed caprification.

This operation as now practiced consists in suspending in the fig trees strings of ripe caprifigs of the spring generation, containing the fig insects ready to emerge. The spring generation caprifigs, or *profichi*, are ripe in June or July, just when the young edible figs are large enough to allow the insect to enter the mouth, and when the female flowers are receptive. These spring generation caprifigs contain abundant male flowers, so that when the insects leave them and enter the young figs they carry pollen to the receptive female flowers. It should be noted that the insect is unable to lay her eggs in the normal female flower of the edible fig, and frequently dies within it. The female fig tree is therefore a death trap for the individual insect, although providing indirectly for a future supply of caprifigs. It thus appears that with these insects the less discriminating individual is the benefactor of the species. Only a few insects enter a single fig.

Caprification has been known for at least 2,300 years in the Eastern Mediterranean, and is still universally practiced in the fig regions about Aidin (near Smyrna) in Asiatic Turkey, at Kalamata in Western Greece, and in Kabylia, Northern Africa, the three greatest centers of production of dried figs. It is also frequent in Sicily, South Italy and Spain, but is not possible in cold countries near the northern limit of fig culture, because the insect could not

* History of Animals, Book 5, ch. 26, p. 4.

pass the winter where the *mamme* or winter caprifigs are liable to freeze.

Caprification is sometimes practiced on the caprifig itself in spring when the tree happens to bear no winter generation fruits. In such cases *mamme* from other trees are suspended in the branches, and the insects coming from them enter and lay eggs in the young spring generation caprifigs (*profichi*). Except for such caprification the *profichi* on such trees would not contain fig insects, and would be valueless for caprifying the edible fig in summer.

CAPRIFICATION IN AMERICA.

In 1880 and 1882, Mr. J. P. Rixford, of the San Francisco *Bulletin*, imported into California, by the aid of Consul E. F. Smithers, some fourteen thousand cuttings of the best sorts of Smyrna fig trees, it having been found impossible to prepare from any of the figs then cultivated in California a dried article able to compare with the best Smyrna product. These *Bulletin* cuttings were widely distributed, and hopes ran high until it was found that the trees refused to hold their fruit. The failure was absolute—not a single fruit has ever ripened during these nineteen years of culture, except some few hundred, pollinated by hand, as will be explained below. Believing that the Smyrniots, fearful of competition, had not sent the right sorts, many growers became disgusted and dug up their trees.

In 1890, Mr. George C. Roeding, of Fresno, produced the first Smyrna figs ever ripened in California, by artificially transferring the pollen from the caprifigs to the young Smyrna figs. In 1891, Dr. Eisen repeated this experiment at Niles. It was necessary to shake the pollen out of the caprifigs and introduce it with a quill into the young fig. From this time it became evident that it would be necessary to import the *Blastophaga*, since the artificial fertilizing of the figs was too slow and too expensive an operation to be applied in practice in the culture of Smyrna figs.

In 1890 also, the Division of Pomology of the Department of Agriculture had imported and distributed cuttings of these male or caprifig trees, together with the insects, but the latter were, of course, unable to survive in the absence of trees producing the necessary succession of caprifigs. Mr. James Shinn, of Niles, secured the insect in the summer of 1891, and Mr. Anthony C. Denotovitch in 1895, but in both cases with no result. Dr. Riley, then Entomologist of the Department, had devoted much thought to the matter, and in 1891 and 1895 he published papers calling attention to the importance of introducing the insect.

Having become interested in the subject of caprification through acquaintance with Dr. Paul Meyer while studying at the Naples Zoological Station in 1896, and having had placed at my disposal, through the liberality of Director Dohrn, the unequaled facilities of that institution, I entered upon a second and more detailed study in 1898. In this I was most kindly assisted by material and suggestions from Dr. Meyer and Count Sohms-Laubach. While engaged in this investigation, the results of which are soon to be published, a test was made, on private responsibility, of a method of mailing the winter caprifigs wrapped in tinfoil after the cut end had been sealed. This simple expedient proved effective, and the contained insects reached California in good condition. Meanwhile Dr. L. O. Howard, Entomologist of the Department of Agriculture, had determined to attempt the introduction of the *Blastophaga* and was in California in the interest of such an undertaking. The shipment accordingly received his personal attention. Although the insects failed to establish themselves, the experiment showed the advantage of sending the small, firm, winter caprifigs rather than the larger and softer spring generation, which had been

used in previous attempted introductions. In the spring of 1899, while traveling for the Section of Seed and Plant Introduction, I again sent winter caprifigs from Naples, and also, in considerable numbers, from the fig-producing regions of the mountains of Algeria. These also endured the journey well, and on arrival at Washington they were turned over to Dr. Howard, under whose direction they were liberated by Mr. Roeding in his extensive orchards at Fresno. This time the introduction was successful, and *Blastophaga* is now breeding in California, and, it is hoped, may pass the winter and become permanently established.

The principal fig growing regions of North Africa, Italy, Greece, and Asia Minor were also visited in order to learn the methods of culture there pursued, and the conditions necessary to the life of the insect. In the spring of 1898, when the fig orchards about Smyrna were severely frozen, the extraordinary price of from one to three dollars a pound was paid for caprifigs from islands of the Archipelago and from Western Greece, to be used in restocking the orchards with the *Blastophaga*. From one to two cents a pound is the ordinary price of caprifigs. Some lucky owners of large caprifig trees realized fabulous sums for their crop, much more than would ever be obtained from a tree producing edible figs.

Caprifigs are by no means all wild, as commonly supposed, but are extensively propagated and exist in several named and well-known varieties in Greece and Asia Minor. It is further worthy of note that the *profichi* which are produced by certain trees often have a value greatly superior, and there is reason to suppose that some sorts produce not only more *profichi*, but more insects to the fig, and furthermore do not harbor the mess-mate, *Philotrypesis ficaria*, which is considered injurious by growers. I was shown a fig tree in Algeria to secure the fruits of which natives often journeyed twenty or thirty miles. Another yielded *profichi* which sold in 1897, for seven dollars; and in Patras, Greece, I saw a third tree which had brought in as much. These facts give some idea of the views of the natives as to the importance of the process of caprification, which, indeed, all testimony agrees in proving to be *absolutely necessary* for securing a crop in all figs of prime commercial value in the dried condition.

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SCIENTIFIC BOOKS.

Praxis und Theorie der Zellen- und Befruchtungslehre. By PROFESSOR VALENTIN HÄCKER. Jena, G. Fischer. 1899. 260 pp. 137 Figs.

The last decade has witnessed the appearance in a large number of biological laboratories of a new course of study, now becoming generally known as cellular biology or cytology, which has created new demands in the way of text-books and laboratory methods. In its morphological aspect this study is nearly related to, and strictly speaking forms a part of, the older histology; though a practical ground of distinction lies in the fact that cytology is principally concerned with the anatomy of the cell considered as an individual, while histology includes also the comparative anatomy of the tissues. Cytology covers, however, a much wider field than that of cell-anatomy, for a very important part of the study relates to the processes of cell-reproduction and cell-physiology, including the phenomena of cell-division, the maturation and fertilization of the germ-cells, the physiological relations of nucleus, cytoplasm, and other cell-organs, and many cognate problems relating to growth and development. The subject thus becomes one of very wide scope, and indeed joins hands with every branch of biology that can be studied from the cell-standpoint. As practically taught, however, cytology is still largely occupied with cell-morphology and reproduction, and the historical development of the subject has been such as to concentrate the attention of cytologists to a considerable degree on the structure of the reproductive organs and on growth, division and

related phenomena, as displayed in the history of the germ-cells and in the early stages of embryological development. This tendency of cell-research, with which students of cytology are sometimes reproached, is not wholly due to the high theoretical interest of the germ-cells. It is in large measure a result of purely practical conditions, such as the large size of the cell-elements in germ-cells or embryonic cells, the ease with which they may be obtained in all stages of development, and the accurate control of results thus rendered possible. Similar reasons may be given for the large share of attention that has been devoted to special forms of tissue-cells, such as the epithelial cells and leucocytes of salamander-larvæ, or the embryonic cells of plant-tissues. Cytological teaching has inevitably followed in the main, the lines of research; and thus it has come to pass that in practice, courses in cellular biology cover a very different field from those in histology, requiring special material and employing special methods.

Botanical students have been fortunate in the existence of Strasburger's well-known *Botanisches Practicum* which, though primarily devoted to general botanical morphology, also contains valuable directions for the practical study of plant-cytology. Students of zoology have had no lack of general works, such as those of Flemming, Carnoy, Bergh, Hertwig, Henneguy and Wilson, not to mention a number of admirable works on histology; but with the exception of Carnoy's *Biologie Cellulaire*, published fifteen years ago and the first of its kind, none of these works contain practical laboratory directions. Carnoy's work is now too far out of date to be of much service to the modern student, and the same applies to Whitman's excellent *Methods in Microscopical Anatomy and Embryology* published in 1885. A. Bolles Lee's *Microtomist's Vade-mecum*, especially in the German edition, translated and revised by Paul Mayer, is indispensable to all students of microscopical anatomy, yet even this work does not supply the want which Häcker has now endeavored to meet.

The '*Praxis und Lehre*' will, we feel sure, be of the highest service both to students and to teachers of cytology. As the name indicates, it is not properly a laboratory manual, but happily combines practice with descriptions of fact and the discussion of theory. The plan followed is to describe a series of 'objects,' each accompanied by practical directions for the collection and preparation of material, a brief and clear account of the topic which it illustrates, and a review of the earlier history and more recent literature of the subject. The methods, like many of the descriptions, are in the main compiled from recent original works, and the author has wisely omitted all accounts of elementary operations such as the use of the microscope, methods of section-cutting and the like, which are adequately treated in Lee's and other manuals. The student is thus brought directly to the real subject-matter and is enabled to gain a connected idea of the facts, learning at the same time how to procure and prepare the material for first-hand knowledge. Some of this material, it is true, is not readily procurable, some is practically out of the reach of all who are not specialists. Professor Häcker has none the less rendered a good service, especially to teachers, by bringing together in readily available form the widely scattered accounts of material and method given by special investigators. The book is a model of clearness and brevity, and is well illustrated by figures drawn as far as possible from the latest sources. While we do not doubt that further experience will suggest many improvements on the practical side, the book may be heartily recommended as a most useful adjunct both to lecture-courses and to practical work in cytology, and one that cannot fail to give a stimulus to the study.

E. B. W.

The Teaching Botanist. By WILLIAM F. GANONG, PHD., Professor of Botany in Smith College. New York, The Macmillan Company. 1899. Pp. xii + 270. Price, $1.10.

The growth of interest in the teaching of botanical science has found expression in the publication during the past few years of a liberal number of books, concerned in one way or another with this teaching. Up to this time these works naturally fall into two categories—that of the text-book and of the laboratory manual—and although some attempt has been

made to combine the virtues of these two classes in one book, no very marked result has been delivered. Attempts have also been made to embody advice and suggestions to the teacher in minor paragraphs, but these have been necessarily meagre and their educational value somewhat doubtful. The teaching body, therefore, has been waiting for the right kind of help—help which is not sandwiched into the text-book or into the laboratory manual, but designed for the teacher solely. This has been given them in the work before us, one which is divided into two parts, the first part consisting of 'Essays on Botanical Pedagogics,' the second of 'An Outline for a Synthetic Elementary Course in the Science of Botany.' The author in his preface calls attention to the fact that in the opinions of many teachers the 'vital phenomena, especially as they manifest themselves in moulding the physiogomy of vegetation,' should form the backbone of an elementary course in botany, and while admitting the value of this as an ideal, remarks that the problem of the topography of vegetation is far too complex a matter, too far beyond our understanding to be available in general courses. It appears to the reviewer that this is well said, for we are now experiencing a swing of the pendulum towards the use of ecology which will have to be lessened before the proper mean is arrived at. Passing on to the introduction we find the key to Professor Ganong's position as to what should constitute an elementary course. He says, "it must embody the essence of the best human knowledge of the leading divisions of the science, and that it must include training in those qualities by which that knowledge is gained."

The first part is made up of eight chapters, to the captions of which it is worth while here to draw attention. They are as follows: (1) The Place of the Sciences in Education and of Botany among the Sciences; (2) What Botany is of most Worth; (3) On Things Essential to Good Botanical Teaching; (4) On Scientific Recording, Drawing and Description; (5) On Laboratories and their Equipment; (6) On Botanical Collections and other Illustrations; (7) On Botanical Books and their Use; (8) On Some Common Errors Prejudicial to Good Botanical Teaching. It must be left to the titles to suggest the scope and usefulness of these essays, with the assurance that the one who is interested will not be disappointed. It may be well, however, to point out a few matters of special interest which will serve to indicate the character of the whole. In facing the problem of the crowded curriculum, the author makes the plea that the Natural Sciences should be added to the curriculum as alternatives with the older well-established branches. Following which is an argument for a limited elective system in the schools. The contents of the second chapter has already been indicated in a sentence from the introduction. Among features deemed essential to good botanical teaching is a 'determination for incessant improvement.' This involves work in original investigation, as it is truly regarded as the only way in which the teacher can cultivate the right scientific spirit. In the sixth chapter the matter of collections is dealt with; the author emphasizes the necessity of making a collection mean something, which is seldom enough the case. We have passed beyond the cabinet stage of development. The last of the chapters deals with common botanical errors, most of which grow out of the partial failure on the part of teachers to readjust themselves to the newer phases of botanical thought, and although this chapter would be unnecessary, if the contents of the third essay had not been violated, it is under the circumstances not the least necessary of the series, as the reviewer can say from his own experience in contact with teachers. The value of these essays is here only suggested, and while it is certain there will be some disagreement as to minor features—for when has there been entire agreement among the teachers?—the whole forms a well-balanced, corrective and stimulating body of matter.

The second part embodies in outline what in the author's experience has proved to be the most profitable course of study for elementary students. The course consists in the study of the seed, germination, the seedling and the differentiated plant, with inquiry into the structure, physiology and ecology of the same. A series of a dozen simple experiments has been worked out to illustrate the essential physiolog-

ical processes in plants and is here presented. Following the treatment of the Spermatophytes in the manner indicated is work on the great groups of plants. There will be some who will take exception to the choice of types. Marchantia, for example, is a very antiquated and highly respectable laboratory type and possesses historical inertia, but it is hardly the best possible representative of the Hepaticæ. Concerning these outlines it may be said that only the broad lines are laid down, and plenty of work is left for the teacher to do in intelligently planning the details of the laboratory work. The most valuable and distinctive feature in this portion of the book is the discussion of the pedagogics involved in each stage of the course. These must be passed with bare mention, though they deserve full treatment.

It is satisfactory to know that morphological study is considered of great value in the training of students and that the diagrammatic rather than the artistic representation should be required.

A few inadvertencies have crept in. Longitudinal sections of a Scilla or Hyacinth flower passing through two stamens will not give an appearance of the ovary as represented in pages 239 and 240, as such sections would pass through one of the partitions. It is not at all certain that the willow flower is theoretically primitive, and much more uncertain is it that 'color develops * * * to show where the nectar is.' Insects at least, it appears, are probably color-blind, but possess a keen sense of smell. And it is to be hoped that the essay on page 175 will not be read as an example without drawing attention to the incorrect use of the word 'endosperm,' for which 'food materials' would better be substituted.

Altogether, however, we have in Professor Ganong's book a very useful and timely work, which will surely do a great deal towards the bettering of botanical teaching in the schools, and one, moreover, as unique as useful.

Francis E. Lloyd.

Teachers College.

Reye's Geometrie der Lage. Lectures on Geometry of Position. By Theodore Reye, Professor of Mathematics in the University of Strassburg. Translated by Thomas F. Holgate, M.A., Ph. D., Professor of Applied Mathematics in the College of Liberal Arts in Northwestern University. New York, The Macmillan Company. 1898. Part I., 8vo. Pp. xix + 248.

As is well known this book, of which the first edition was published not more than thirty years ago, is the outgrowth of lectures delivered before the engineering students in the Polytechnic school at Zürich. These students were later to take lectures on Graphical Statics by Professor Culmann who, in the treatment of his subject, made free use of Von Staudt's 'Geometrie der Lage.' To get the most out of Culmann's work it was necessary that the student should not only be well acquainted with the conics, quadric surfaces, etc., but that he should also have what may be called a well-cultivated geometric imagination, in order that he might easily realize for himself a clear mental picture of the space figures which play such an important part in the engineer's work.

It is hardly too much to say that for the special purpose he had in view, no better means than the projective geometry could have been employed by Professor Reye; and one who has read his masterly treatment of the subject must always be grateful to him for the pleasure and profit derived therefrom.

It seems to us that there is a rapidly growing interest in pure geometry in this country, and that its real merit as an instrument of education is coming to be more fully recognized. Rightly presented, the charm of the subject itself, which is free from the trammels of the metric geometry of Euclid, is immediately experienced by students.

Although the geometry of position is often introduced by means of cross ratios, which (at least apparently) involve measurements, yet Reye's treatment is entirely free, even at the beginning, from any dependence upon metric relations. He has, however, beautifully shown that metric relations, especially those connected with the conic sections, present themselves very naturally as special cases of general non-metric theorems.

This, of course, may also be said of two other excellent books, viz., Cremona's 'Projective Geometry' and Von Staudt's 'Geometrie der Lage'; but Von Staudt is too brief to be easily

read by a beginner, and Cremona, as translated by Leudesdorf, seems rather unattractive, and certainly lacks the charm of Reye's lucid style.

It seems to us, therefore, that the translator has rendered a great service to English-speaking students in translating this first part of Reye, and we earnestly hope that sufficient interest in the study of pure geometry will be awakened by having this very attractive book available for beginners, to make him feel that his unselfish labor has not been in vain.

Whether it is worth while to translate the other parts also (Parts II. and III. carry the subject far beyond its elements) is, however, very questionable—because those of our students who are sufficiently advanced to understand the subjects treated are able to read the German about as readily as the English.

The translation itself is also, as a whole, to be heartily commended; the charm of the original has been preserved, many valuable exercises have been added, and the breaking up of the lectures into numbered paragraphs, as well as the rearrangement of the exercises so as to have those that are appropriate thereto follow each lecture, are distinct improvements.

It is, however, to be greatly regretted that the translator has seen fit to change a well-established and everywhere understood terminology. For example, he replaces the terms *pencil* and *sheaf* (which are already, and for many years have been, well-nigh universally employed to represent particular geometric concepts), respectively by the terms *sheaf* and *bundle.* While it may be granted that these new terms are in themselves just as good as, and possibly even a trifle better than, those for which they are substituted, yet nothing of importance is gained by the change, while the danger of confusion and misunderstanding is greatly increased.

J. H. Tanner.

Cornell University, October 4, 1899.

BOOKS RECEIVED.

Bacteria. George Newman. New York, G. P. Putnam's Sons. London, John Murray. 1899. Pp. xiv + 348.

Cambridge Natural History. Vol. V. *Insects.* Part II. David Sharp. London and New York, The Macmillan Company. 1899. Pp. xii + 626.

A Dictionary of Birds. Alfred Newton, assisted by Hans Gadow. New York, The Macmillan Company. London, Adams & Charles Black. 1893–1896. Cheap issue, unabridged. Pp. iii + 1088. $5.00.

The Insect World. A Reading Book of Entomology. Clarence Moores Weed. New York, D. Appleton and Company. 1899. Pp. xvi + 210.

Indicators and Test-Papers. Alfred I. Cohn. New York, John Wiley & Sons. London, Chapman & Hall, Ltd. 1899. Pp. ix + 249.

A System of Medicine by Many Writers. Vol. VIII. *Diseases of the Nervous System.* Continued. Edited by Thomas Clifford Allbutt. New York and London, The Macmillan Company. 1899. Pp. xii + 937. $5.00.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, October, 'On the Paraanisaldoximes,' by H. R. Carveth: a study of the two modifications; 'On the Relation between Pressure and Evaporation,' by Edwin H. Hall; 'The Electrical Conductivity of Non-Aqueous Solutions,' by Azariah T. Lincoln: an account of the experimental work of the author, chiefly with chlorides (also silver and lead nitrates, silver and mercuric cyanids, mercuric iodid and copper sulfate), in a well-selected variety (27) of solvents, all organic except PCl_3 and $SnCl_4$. Some substances were insoluble, some insoluble but not conductors of electricity, while others conducted electricity well. Two conclusions of the author may be quoted: "The data collected are as yet insufficient to show what the relation between solvent and dissolved substance must be in order to yield solutions that conduct electricity." "The dissociation theory as promulgated for the explanation of the electrical conductivity of aqueous solutions, apparently cannot be applied in its present form to explain the conductivity in non-aqueous solutions." The article is an important contribution to the study of solutions.

J. L. H.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

The regular meeting of the Section of Biology was held on Monday evening, October 9th, Professor Frederic S. Lee presiding. The

minutes of the previous meeting were read and approved. The following persons were nominated for membership in the Academy: Mr. Maurice A. Bigelow, of Teachers College; Dr. Edward L. Thorndike, of Teachers College, Mr. R. S. Woodworth, of University and Bellevue Hospital Medical College, and Dr. W. Golden Mortimer, 504 W. 146th Street, New York City.

The evening was devoted to reports of the past summer's work by a number of members.

Professor H. F. Osborn gave an account of the exploration by the American Museum party in the Como beds of Southern Wyoming, and of further work in the Bone Cabin Quarry, which resulted in the discovery of a large number of the remains of Dinosaurs. Four miles distant a *Brontosaur* skeleton was found. Parties were also sent to the Freeze Out Mountains and north to the Rattlesnake Mountains, but without success.

Professor E. B. Wilson reported upon his search in Egypt for *Polypterus*, which resulted in the obtaining of a few fine females, but with unripe ovaries; this was in winter, between Assuan and Mansourah. Professor Wilson reported, also, the rediscovery by him of the gill-bearing earthworm, *Alma*.

Professor Bashford Dean reported on the work of the second Senff expedition to the Nile, and spoke of the death of Nathan Russell Harrington, the senior member of the party. Mr. Harrington had for four years identified himself with the Biological Section, and had left with it an enviable example of energetic and persistent effort to complete an important research and of sacrifice and devotion to a life work.

Professor Dean further reported on his work on the California coast while a guest of Stanford University. He was successful during the present summer in obtaining a number of freshly hatched young of *Bdellostoma*, and many developmental stages of *Chimæra Colliei*.

Dr. G. N. Calkins reported the passing of a successful summer at the Marine Biological Laboratory at Woods Hole, where he was at work upon the Protozoa.

Professor F. E. Lloyd gave a brief account of a collecting trip in Vermont, embodying some remarks upon certain species of *Lycopodium* found there. He also reported upon the marked success of the Biological Laboratory at Cold Spring Harbor during the summer.

Professor F. S. Lee spoke on the continuation of his experimental work upon the lateral line in fishes, conducted at Woods Hole.

FRANCIS E. LLOYD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

'THE PERCEPTION OF HORIZONTAL AND OF VERTICAL LINES.'

TO THE EDITOR OF SCIENCE: In connection with Professor Peirce's article on 'The Perception of Horizontal and of Vertical Lines' (SCIENCE, September 29, 1899), it may be appropriate to call attention to a study of the same question made in the Psychological Laboratory of the University of Wisconsin and published in the *American Journal of Psychology* in 1893 (Vol. V., pp. 214–223). Our method consisted in seating the observer under a parasol-like canopy, which completely screened from him all the horizontals and verticals of floor and walls; in then placing opposite him under the canopy a large black disc, upon which was centered a smaller white disc bearing upon it a single line; and in requiring the observer to set this line (by means of strings manipulated by his hands which were outside the canopy) so that it appeared horizontal or vertical. The observer is thus everywhere surrounded by curved outlines, and has no standard to guide him except the ideal one which he carries in his mind. So far as the results of the two investigations are comparable they agree very well, both emphasizing the great accuracy of such 'mental' judgments. Our estimations were made binocularly under circumstances approximating those of the ordinary use of the eyes; Professor Peirce's subjects in the first group of experiments used each eye separately. If we may assume that the average setting of the two eyes used separately is equivalent to the binocular setting of the lines, and further allow that the two methods used are fairly comparable, we find for the mean deviation for Professor Peirce's subjects (average of ten subjects) for the horizontal $+.25°$, for my ten subjects $+.12°$; for the vertical $-.39°$ and $+.23°$. It is better, however, to compare my results with Professor

Peirce's binocular results obtained by looking through a tube 35 centimeters in diameter and 2 meters long. The mean deviation for the horizontal then becomes (average of 29 subjects) — .25° and for the vertical — .56°. The settings are so nearly correct that the direction of the error cannot be regarded as significant; in both sets of observations the excess in number of those who tended to one type of error was not very great upon those who tended to the contrary type. I also investigated the errors for oblique settings. These proved to be much greater, on the average about nine times as large, and with a pronounced tendency to set both the oblique lines in a position nearer the horizontal than the two 'ideal' oblique lines making angles of 45° with the horizontal and vertical.

In the same group of contributions from the Laboratory of the University of Wisconsin may also be found a study of the accuracy with which lines could be set in given positions, when a model or copy was furnished; and a study of the accuracy with which angles may be reproduced.

The variations in the manner of estimating which Professor Peirce has introduced are extremely interesting and contribute something of value to the determination of the factors which influence such judgments of position. I can recall that at the time we were engaged in these investigations, I had in contemplation a set of experiments in which the subject should be required to set vertical and horizontal lines in a room in which contained no true verticals or horizontals or rectangular dimensions. The floor was to be slightly out of the horizontal in one direction, the ceiling in another, while the walls might present various kinds and degrees of divergence from the vertical. How far such an unusual environment might effect one's estimate of the true horizontal and vertical seems an interesting subject of inquiry.

JOSEPH JASTROW.

PSYCHOLOGICAL LABORATORY, UNIVERSITY OF WISCONSIN, MADISON, WIS., October 5th.

THE THIRD PRINCETON EXPEDITION TO PATAGONIA.

MR. J. B. HATCHER and his assistant, Mr. O. A. Peterson, have returned from their third exploration of Patagonia, where they were sent by the Geological Department of Princeton University. The work has been highly successful and admirably supplements that of the two previous journeys. We hope to give later a more detailed report of the results of the expedition, but may state at present that the party sailed from New York on December 9, 1898, and returned August 17, 1899, bringing very extensive collections of both vertebrate and invertebrate fossils of Patagonia, together with much material illustrating the zoology and botany of that region. The work of cleaning and preparing these great collections for study and publication has already made good progress, and is being pushed forward as rapidly as possible.

In a recent report Mr. Hatcher summarized the results of the work for the last three years as follows:

"(1) A good preliminary geological survey of that part of southern South America, lying between the Andes on the west and the Atlantic on the east, and between the Straits of Magellan and the forty-seventh parallel of south latitude, sufficient to serve as a basis for a geological map of the region.

"(2) Very extensive and complete collections of fossils from all the different fossil-bearing horizons known to that region, with the one exception of the Pyrotherium beds.

"(3) The discovery of four distinct and previously unreported geological horizons.

"(4) A collection of more than one thousand skins and skeletons of recent birds and mammals, embracing about one hundred and fifty species of birds and fifty species of mammals, and fairly representative of the mammalian and avian life.

"(5) Extensive collections of the fresh water, terrestrial and litoral invertebrate life.

"(6) Botanical collections, especially of the mosses, Hepaticæ and flowering plants, not including the grasses and sedges."

(7) To the above should be added a large and very valuable series of photographs, illustrating the geology and physical geography of Patagonia.

It is hoped that a series of adequately illustrated monographs will be issued from the Princeton museum containing the results of the

study of these great collections. The geology will be treated of by Mr. Hatcher, the Tertiary invertebrates by Dr. Ortmann, the fossil vertebrates by Messrs. W. B. Scott and Hatcher, and the recent birds by Mr. W. E. D. Scott.

It is difficult to exaggerate the value of Mr. Hatcher's and Mr. Peterson's long and arduous labors. Materials have now been gathered that will make possible the solution of many vexatious and much discussed problems, and for the first time a full and representative collection of the wonderful fossil mammals of Patagonia has been brought to a Northern museum. We can, at last, directly compare the Tertiary mammals of the Northern and Southern Hemispheres, and may hope to reach some definite conclusions concerning the mutual relations of these two faunal assemblages.

A LONG PHOTOGRAPHIC TELESCOPE.

LAST spring a plan was proposed at the Harvard College Observatory for the construction of a telescope of unusual length for photographing the stars and planets. Anonymous donors have now furnished the means by which this experiment may be tried. The plan will, therefore, take definite shape, and it is expected that a telescope, having an aperture of 12 inches and a length of a hundred feet or more, will be ready for trial at Cambridge in a few weeks.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY,
October 12, 1899.

SCIENTIFIC NOTES AND NEWS.

WE announce with great regret the death on October 16th, of Dr. Edward Orton, the eminent geologist, professor in the Ohio State University, president of the American Association for the Advancement of Science.

DR. J. T. ROTHROCK has been reappointed for a term of four years, State Commissioner of Forestry for the State of Pennsylvania.

PROFESSOR GEORG STEINDORFF, the director of the Ægyptologische Sammlung at Leipzig, has, says *Nature*, obtained leave of absence for six months to enable him to undertake a scientific journey to Africa.

IT is stated in *Natural Science* that Dr. Robert Logan Jack, late Government Geologist for Queensland, and special commissioner in charge of the exhibits at the Greater Britain Exhibition, has accepted an appointment from Mr. Pritchard Morgan to run some mining concessions in Szechuan, Korea, and North China. Dr. Jack sailed in September.

AT a sitting of the International Geographical Congress on October 2d, it was announced that Dr. Scott Keltie had received a telegram from Mr. H. J. Mackinder, the reader in geography at Oxford, who has just succeeded in reaching the summit of the hitherto unscaled Mount Kenia (about 18,000 feet), in British East Africa. Mr. Mackinder left England in June last in command of an expedition subsidized by the Royal Geographical Society. The telegram, which was sent *via* Mombasa, states that some 15 glaciers were found upon the mountain.

DR. G. W. HILL will give a course of lectures on celestial mechanics at Columbia University on Saturday mornings beginning October 21st. The subjects treated will be:

I. Delaunay's Method in the Lunar Theory generalized and applied to the Planets.

II. Gyldèn's Method of Perturbations.

III. Gauss' Method with Secular Perturbations.

IV. General Expressions for the Secular Inequalities of the Solar System.

V. Poisson's Theorem on the Invariability of the Mean Distances.

VI. Periodic Solutions in the Planetary Problem.

VII. The Restricted Problem of Three Bodies.

VIII. General Considerations on the Stability of Motion of Planetary Systems.

PROFESSOR R. W. WOOD, of the University of Wisconsin, having received several inquiries as to whether he could furnish lantern slides of the plates illustrating his article on the photography of sound-waves, which appeared in the *Philosophical Magazine* for August, has placed the original negatives in the hands of Miss Blanchard Harper (Madison, Wis.), who is prepared to supply slides from any or all of the plates at a nominal cost. The slides will be found useful in teaching, showing as they do the wave fronts by reflection from all sorts of surfaces, refraction, diffraction, Huyghens' principle, etc.

Major Ronald Ross has now returned from Africa, and is represented to have said that the authorities in Sierra Leone, acting on his advice, are now destroying the virulent mosquito by every means in their power. In the judgment of Major Ross the future of the west coast will be assured as soon as the colonial authorities take similar steps in the neighborhood of the principal towns, although years must elapse before the inland stations are improved.

The Vice-Chancellor of Cambridge University announced on October 4th that he had received the following communication from the Colonial Office: The Government of the Straits Settlements desires to invite the attention of Radcliffe's travelling Fellows and of holders of scholarships for medical and physical research to the study of the tropical diseases called beriberi. This disease caused in the hospitals of the colony 730 deaths in 1896, and 692 in 1897. This government will be glad to assist any scholar who desires to engage in the scientific investigation of this disease in the colony, by providing him with furnished quarters, rent free, by giving him free access to all the hospitals, and facilities for studying the cases therein, by defraying the cost of his passage to the colony, and in any way which may be agreed upon hereafter between the scholar and Mr. Swettenham, the Secretary of the Straits Settlements.

The death is announced of M. Paul Janet, member of the Paris Academy of moral and political science, and formerly professor of philosophy at the Sorbonne.

Mr. Edward Case, an English engineer, well known for his method of groyning to prevent the sea from encroaching on the coast, died on September 22d.

The position of assistant in the bio-chemic division of the Bureau of Animal Industry in the Department of Agriculture, will be filled as the result of an examination on November 7th. The chief subject in the examination will be serum therapeutics. The salary will be $750 per annum.

The charter of the Dental School and Museum of Art, provided for in the will of the late Dr. Thomas W. Evans, the American dentist, who died in Paris in 1897, has been approved by Judge Arnold. The Museum will have an endowment of nearly four million dollars unless the will is broken by the legal contest now in progress.

Mr. Andrew Carnegie has increased his gift for the Washington Public Library to $350,000. At the close of the last session a site on Mount Vernon Square was selected, and it is expected that the construction of the building will be begun very soon.

We learn from *Popular Astronomy* that the new observatory and great refractor of the astrophysical observatory at Potsdam were inaugurated on August 26th, in the presence of the German Emperor.

The fine collection of Scottish agates made by the late Professor Heddle says *Natural Science* is now arranged in the Museum of Science and Art in Edinburgh. Mr. J. G. Goodchild has prepared a guide to the collection, incorporating Professor Heddle's explanatory notes.

The winter meeting of the American Chemical Society will be held at New Haven, Conn., during Christmas week. As last year in New York the Society will meet at the same time and place as the American Society of Naturalists and affiliated societies.

About seventy members of the British Association took advantage of the trip through France and Belgium arranged to follow the Dover meeting. They were officially welcomed in the different towns and cities that they visited.

The Fourth International Congress of Applied Chemistry is to be held in Paris from the 21st to 23d of July, 1900, with M. Berthelot as honorary president, and M. Moissan as president. An American Committee on Organization has been formed consisting of: Section I.—*Analytical Chemistry*, W. L. Dudley, W. F. Hillebrand, J. H. Long, Elwyn Waller; Section II.—*Inorganic Products*, Edward Hart, Edward W. Morley, J. D. Pennock; Section III.—*Metallurgy, Mines, Explosives*, F. W. Clarke, C. B. Dudley, C. E. Munroe, H. H. Nicholson; Section IV.—*Organic Products*, Thomas Evans, Wm. McMurtrie,

Ira Remsen, Clifford Richardson, S. P. Sadtler; Section V.—*Sugar Industry*, Edward Gudeman, W. D. Horne, G. L. Spencer, M. Swenson, Edward B. Vorhees; Section VI.—*Fermentations*, C. A. Crampton, W. B. Rising, Alfred Springer; Section VII.—*Agricultural Chemistry*, *Fertilizers*, *Cattle Feeding*, *Dairy*, G. C. Caldwell, L. L. Van Slyke, H. W. Wiley; Section VIII.—*Hygiene, Medical and Pharmaceutical Chemistry*, W. O. Atwater, R. H. Chittenden, J. U. Lloyd, Wm. P. Mason, Wm. J. Schieffelin; Section IX.—*Photography*, C. F. Chandler, J. H. Stebbins, Jr., E. R. Hewitt; Section X.—*Electro-Chemistry*, Elihu Thomson, Edgar F. Smith, Charles A. Doremus, Chairman of the American committee.

THE Twelfth Congress of Orientalists convened at Rome on October 4th, with about 400 delegates in attendance.

AT a meeting of the Trustees of New York Public Library on October 11th, the Director, Dr. John S. Billings submitted his annual report. The number of books received for the 'shelf department' and catalogued in the year was 34,182, of which 16,994 were purchases and 17,188 gifts. The Ford gift is estimated at about 100,000 volumes and pamphlets. The total volumes actually received was 55,593, and the pamphlets 101,698. On the shelves and available for use at the end of the year were 459,248 volumes and about 117,000 pamphlets. The number of readers who visited the two buildings was 111,038. This is an increase of 7,000 over the previous year.

ACCORDING to *Natural Science* an interesting experiment is being made by the government of Bosnia and Herzegovina in connection with the subject of the migration of birds. A number of observatories are being established all over these two countries, on the coasts, plains, mountains, rivers and lakes—in fact, in every spot which seems likely to yield results of interest to those engaged in researches on bird migration. Under the auspices of the government of the two countries named, a meeting of ornithologists was convened at Sarajevo from the 25th to the 29th of September, with a view to similar observations conducted on uniform methods being instituted elsewhere. A report was presented on the bird life of the Balkan States, illustrated by a fine collection from those districts.

BOTANISTS should feel under obligations to us for calling their attention to the description of a new species, as it appeared in a daily paper where it might be overlooked. We regret that the n. sp. is not figured. The description is in the following paragraph from the London *Daily Chronicle*:

The Pope takes great interest in an electric plant, to which he has given the name 'Officina Electrica Vaticana Alessandro Volta,' in honor of Volta. A few days ago his Holiness made a special inspection of these plants, and the employees of the Vatican gardens were presented to him by the chief.

UNIVERSITY AND EDUCATIONAL NEWS.

IN fulfillment of the terms of the will of the late Edward Austin, the president and fellows of Harvard College, have voted that, until they shall give further orders, $2,000 shall be assigned yearly from the income of his bequest of $500,000 to establish eight scholarships, each with an annual value of $250, to be awarded for one year to superintendents of schools and to teachers in secondary schools and colleges, who have been recently in service and intend to return to service. Several of these scholarships have been awarded including one to R. E. Gaines, professor in Richmond College, and C. V. Piper, professor of biology in the University of Washington.

D. F. CONVERSE, a mill owner of Spartanburg, S. C., who died a week ago, left one-third of his estate, valued at $500,000, to Converse College, an institute for the higher education for women founded by him in Spartanburg ten years ago.

THE expenses of the University of Chicago for printing and publishing during the academic year ending June 30, 1899, were over $44,000, whereas the receipts were only $17,000. It is probable that no other university supports its publications with such liberality.

PROFESSOR GEORGE HARRIS was formally inaugurated as President of Amherst College on October 11th. In the course of his inaugural address President Harris clearly stated that a scientific education has a culture value equal to

classical studies. He said that the high schools could not be expected to teach Greek, and that the colleges must accept the preparation given in the high school. "Granting that culture is the primary object of education, it does not follow that there is only one kind of discipline, as the classical—that the ancient languages and mathematics are the only regimen for making the man of letters. The equation of culture may have for its second term almost any actual knowledge." When study of the classical language "degenerates into mere language drill, and when thousands, in fact, never get beyond that, or cannot read a passage at sight, the value of such study is not obvious. Allow, however, the full worth of the classical discipline. Yet even so there are other studies now of equal or greater value."

The inauguration of President Faunce, of Brown University, took place on October 17th. Addresses were delivered by Presidents Patton, Harper, Elliott and Faunce.

The Council of the University of Melbourne will shortly appoint a professor to the chair of geology and mineralogy. *Natural Science* states that the professor is expected to devote the whole of his time to the work of his department, and will be required to deliver two courses of lectures of three hours a week each, and to undertake the training of students both in field and laboratory work. The salary of the professor is £1,000 per annum, but in the event of the Council providing him with a residence in the University grounds, the sum of £100 per annum will be deducted from his salary as aforesaid. The University has a fair collection in paleontology and mineralogy, but has no specially fitted up laboratory for geological work. A suitable room in the University buildings will be provided in which to organize this part of the work. Lectures begin in 1900, on Thursday, March 1st. The salary of the office will commence from the 14th February, 1900, or from the date of the Professor's arrival in Melbourne, if later than the 14th February. If the professor appointed come from Britain or America, £100 will be allowed for travelling expenses.

Professor J. B. Johnson was inaugurated as Dean of the College of Mechanics and Engineering of the University of Wisconsin on October 18th.

Mr. Clark Wissler, of Ohio State University, has been appointed assistant in psychology in Columbia University.

Dr. Merton L. Miller has been appointed to an associateship in anthropology in the University of Chicago.

Daniel P. MacMillan, Ph.D., '99, has received an appointment in the Child-study Department which was recently created in the public schools of Chicago.

The following have been appointed instructors in zoology in the University of Michigan: Dr. H. S. Jennings (last year instructor at Dartmouth), Dr. S. J. Holmes and Dr. K. W. Genthe (Leipzig).

Dr. J. B. Johnston (last year instructor in zoology at the University of Michigan) has become assistant professor of biology at the University of West Virginia, Morgantown.

H. W. F. Lorenz, A.B. (Wittenberg), and Ph.D. (Berlin), has just assumed the position of instructor in organic chemistry in the University of Pennsylvania. Dr. Lorenz is the translator of Löb's *Organic Electrosyntheses.*

W. L. Hardin, S.B. (Buchtel College), Ph.D. (University of Pennsylvania), who held the position of fellow and later senior fellow in chemistry in the University of Pennsylvania, has recently been appointed to an instructorship in the same institution. He is the author of 'Liquefaction of Gases' recently published by Macmillan & Company.

Jos. H. James, Ph.D. (University of Pennsylvania), has just been appointed acting professor of chemistry in Buchtel College, Akron, O.

Geo. E. Thomas, S.B., Ph.D. (University of Pennsylvania), has been elected instructor in chemistry in Swarthmore College, Pa.

Miss Lily G. Kollock, A.B., (Woman's College), Ph.D. (University of Pennsylvania), has been appointed to an instructorship in chemistry in Vassar College.

Herbert N. McCoy, Ph.D. (Chicago), has been appointed instructor in chemistry in the University of Utah.

SCIENCE

FRIDAY, OCTOBER 27, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE HISTORY OF THE BEGINNINGS OF THE SCIENCE OF PREHISTORIC ANTHROPOLOGY.**

I.

CONTENTS.

Denmark.
Dolmens.
Shell Heaps.
Lake Dwellings.
Discoveries of Darwin and Boucher de Perthes.
Differences between Paleolithic and Neolithic Cultures.
Paleolithic Implements described.
River Drifts, Valleys and Terraces.
Climate—Differences in.
Epochs of the Cavern Period.
High Plateau Paleoliths.
Tertiary Man.
Pithecanthropus, Dubois.
Neolithic and Bronze Ages Continuous.
Physical Anthropology.
Classification of Races.
Anthropology—the Science of Man.
Subdivisions of Anthropology.
United States.
Paleolithic Age in the United States.
Antiquity of Red Race in America.
Migrations of Red Race in America.
Similarity of Human Culture no Evidence of Similarity of Race, but is of Intercommunication.
Monuments, Burial Mounds and Tumuli.

THE BEGINNINGS OF THE SCIENCE OF PREHISTORIC ANTHROPOLOGY.

Denmark.

Scientific investigation into prehistoric anthropology began in Denmark in the

* Address by the Vice-President and Chairman of Section H, American Association for the Advancement of Science, Forty-eighth Meeting, Columbus Meeting, August 21, 1889.

early part of the present century. Its start was more the result of accident than design. The King of Denmark provided, in 1806, for a scientific investigation of his country, corresponding in some degrees with the aggregate duties with what in our country are the Geological Survey, the Natural History Division of our National Museum and Department of Agriculture, and the Bureau of Ethnology.

Dolmes.

Almost the first obstacle the Committee met, and which, being unable to explain, caused it to put on its studying cap and led to an extensive discussion, was a dolmen, one of the common and now well-known prehistoric burial places. Associated with the discovery were the stone hatchets, both polished and chipped for polishing, also now so well known. The studies of the historian and archeologist failed utterly in assigning any of these to any period or people known in historic times. The ancient Sagas were studied in detail, but never developed an age of culture, wherein axes other than those of iron were used. As the Commission's investigations were extended, the number of these objects, both dolmens and axes, were increased, and other implements were added to the list.

Denmark kept the lead in her interest in the discoveries relating to prehistoric man, and in the formation of the new science which was to become prehistoric anthropology.

Shell Heaps.

Another Commission was formed, composed of Professors Forschhammer, Steenstrup and Worsaae, the latter of whom was the special representative of the Science of Archeology, though the other two would, perhaps, have been equally as great in archeology had they not already been celebrated by their earlier work in biology and geology. Worsaae's labors as an archeologist were overshadowed by his subsequent greatness as a statesman; he became one of the Cabinet Ministers of the Kingdom, and died in office.

The Committee continued the investigations into the new science by the discovery of the shell mounds. That at Havelse was first and became the representative specimen, but it was soon found that shell mounds or deposits existed along the coast in every direction, and what had theretofore been supposed to be the natural surface of the land, was really the result of human labor and the evidence of human occupation. The farmers and land owners in their respective neighborhoods had already discovered that these mounds were not composed of the usual sand and clay, but mostly shells, which, in a state of great decay, were more or less mingled with black soil; and they had carted away much of the material to be distributed over the surface of their fields for enrichment.

An investigation commenced at Havelse, showed not only the artificial character of these shell mounds, but the presence of many pieces of stone, principally flint, which had been broken in such way as to indicate human intervention and an adaptation to human use. These objects ran pretty nearly the entire range of prehistoric implements as we now know them: hammerstones, axes, hatchets, flakes, scrapers, arrowpoints, spearheads, knives, spindle-whorls, gouges, crescents, daggers, etc. There were also objects of shell, horn and bone, and many fragments of pottery.

The more important implements from certain deposits were found to be of stone, with a piercing point or a cutting edge, mostly chipped into shape, though some had been pecked or battered and then ground or polished.

In other deposits objects of different material were found, and among the rest the presence of bronze implements was detected.

The number and kind of these implements, their methods of burial or deposit, with the associated objects, enabled the archeologist to assign to them a chronological sequence ; first in epochs of culture, and second in improvement made within these groups.

These epochs of culture divided themselves according to the material employed for cutting implements, into the ages of stone, bronze and iron. This was the first step in the establishment of the new science of Prehistoric Anthropology. The Royal Danish Museum of Antiquities was established in 1816, now occupying the Princessen Palace at Copenhagen. It was to be the home of the archeological collections of the Kingdom, and here Mr. Thomson with the aid of Professors Forschhammer and Steenstrup, classified, arranged and displayed the objects found, and here the new science was born.

Lake Dwellings.

In 1853 and 1854 the waters of the Swiss Lakes were from natural causes reduced to a low stage, and Dr. Ferdinand Keller employed the opportunity to investigate certain peculiarities which, reported to him by the fishermen and builders on the water's edge, had excited his curiosity. One of these was that certain localities, with a sloping shore apparently well suited for drawing the seine, were rendered useless for this kind of fishing because of obstructions believed to be decayed stumps of a submerged forest covering the bottom, catching the lead-line which had to be lifted, the lifting of which allowed the fish to escape. It appeared that excavations had been made during a period of comparatively low water, in the year 1829, as for a building, wherein the piles and other objects of great antiquity, believed to have been Roman, had been found. Being thus satisfactorily accounted for, their discoverers gave them no further heed, and the objects were not brought to the attention nor submitted to the inspection of any antiquarian. Dr. Keller's first surprise was at the number of these stumps, the similarity of their appearance, and the regularity with which they had grown. His surprise was increased when, on lifting one out from its bed, it was found *not* to be a stump, but a sharpened and pointed pile-bearing evidence of human workmanship, which had been driven into the ground. A cursory examination showed this to be the condition of all. This was evidence of a previous human occupation ; and as the late discovery in Denmark began to have its effect upon the mind of Keller, it became apparent that these were the evidences of a human occupation of the Swiss Lakes at some prehistoric period. This ripened into a certainty when it was discovered that like conditions existed in other places, not only in Lake Zurich, but in divers other of the lakes. Reports of these from both Switzerland and Denmark, spread over western Europe and naturally excited the interest and curiosity of many thinking men, especially those of France and England. The objects themselves were passed about, and descriptions of them with illustrations were brought under the eyes of the people of these countries, who turned their attention to similar known objects of their own countries theretofore unrecognized. Like the discoveries in Denmark and Switzerland, the great interest centered in the similarity of the respective implements in the various classes found in these widely-separated countries. If I recur to this question of the similarity of implements found in different countries, it is because of its importance. It formed the foundation of the science. It was by reason of this similarity that the Scandinavian discoverers and early students were able to determine the prehistoric ages. By comparison of imple-

ments of their own countries with those of Scandinavia, and a recognition of the similarity between them, the students from other countries of Western Europe were enabled to correlate and identify the culture of the prehistoric man; and this knowledge finally crystallized into the universal recognition of the three prehistoric ages of stone, bronze and iron. The prehistoric man had but few kinds of implements: the hammer or maul, the hatchet, the knife, scraper, arrowpoint and spearhead, spindlewhorl, points of bone and horn, objects principally ornaments, of shell and pottery. These implements were substantially the same in every locality so far as concerned the Neolithic period. The polished stone hatchets were identical whether found in the dolmens of France and England, the dolmens and shell heaps of Scandinavia, the lake dwellings of Switzerland, or the terramare of Italy; and in after years, as our knowledge of the prehistoric world increased, this similarity was found to extend throughout the Eastern and Western Hemispheres, as well as the islands of the sea. The similarity was not confined to one class of implements, but included nearly all in every age. To be sure, there were minor differences, but the implements could be recognized as the same whenever found. For example, the hatchets were long or short, had a head or poll, well finished or left rude, and were round, flat or square in section. Those square in section were from Scandinavia; short stumpy ones with unfinished poll, from the British Islands; the poll pointed or rounded and well finished, from Continental Europe; the button-headed, from Brittany. But with all this, they were always the same implement. The material might differ with the locality, but otherwise, as to use and method of manufacture, they appeared the same. As investigation proceeded, this similarity of implement extended. The polished stone hatchet of America was found to be the same, with the same differences of detail; some from Illinois, made of flint, have a spreading edge, almost of a crescent form, the corners forming the points after the style of some of the battle-axes of medieval knights; those from Chiriqui are flattened on both sides by a sort of chamfer which makes them appear hexagonal in section. It has been argued that this similarity of implement was due to the similarity of human thought adapted to human necessity. The similarity of human thought and action under the same necessities may be admitted, although it necessarily had its limitations.

The similarity of the implements found among different peoples widely separated, is not accounted for by the theory of human thought and human needs. The classification of prehistoric culture into ages of stone, bronze and iron was based on the similarity of the implements in each age found in the respective countries, and this was the result of migration, communication or contact between the peoples.

Discoveries of Darwin and Boucher de Perthes.

By the middle of the century students of prehistoric matters of the Old World had about accepted the prehistoric ages of stone, bronze and iron. Some attempts were made to discover the man who had made and used these implements; and the few skulls that had been gathered in earlier times, the significance of which had not then been understood, were subjected to reexamination in view of the new light upon prehistoric matters. Chief among these were the Canstadt skull, discovered in 1706, and the Engis skull, in 1822. In these studies the pathway of prehistoric science and knowledge was being slowly blazed when, in the year 1859, two great discoveries relating to the origin and antiquity of man were published which had something

of the effect of an earthquake upon former scientific conclusions. One, the origin of the human species through evolution, by Darwin; and the other, the acceptance as artificial of the paleolithic implements found by M. Boucher de Perthes in the valley of the Somme. Boucher de Perthes had, as early as 1836, but seriously since 1841, been investigating the peculiarities of certain chipped flints found at Abbeville, France, as far south as Amiens, along the line of the canals and railroads then in course of construction. These he had recognized as the work of man, and claiming for them the highest antiquity, he asserted them to be antediluvian. His discovery was at first unfavorably received. In 1853 Dr. Rigollot announced his adhesion to the theory; in 1859 Dr. Falconer discovered the presence of the bones of *Elephas antiquus* at St. Acheul, and their association more or less intimate with the chipped flint implements of Boucher de Perthes. In 1859 numerous geologists of England visited the locality and some of them, especially Mr. Arthur J. Evans, now Curator of the Ashmolean Museum, Oxford, then a lad accompanying his father, Sir John Evans, had the good fortune to find one of the chipped flint implements *in situ*. There was much contention over the proposition connecting man with these implements, and there were many unbelievers. Some disputed the antiquity of the deposit, others the human manufacture of the implements and, curiously enough, the greatest opposition came from the French geologists and the greatest support from the English. It is not here declared that the geological formation was not early understood by eminent scientists who visited the locality, but there does not appear to have been any publication *in extenso* of that formation and the strata of which it is composed and the fauna found therein, until that of M. D'Ault Du Mesnil in the *Revue Mensuelle de l'Ecole d'Anthropologie* (Sixieme Année, IX., 1896), and of which I translated and published the general portions in the *American Antiquarian* (Vol. XXI., No. 3, 1899, pp. 137–145).

There were found to be several geologic and paleontologic strata. In the lower layers the bones and teeth of *Elephas meridionalis* were found associated with the *Rhinocéros merkii;* in the middle strata the *Elephas primigenius* and the *Elephas antiqusu* were mingled; while in the upper layers the *Elephas primigenius* alone appeared. The implements in the lower strata were large and rude, while in the upper they became smaller and finer and better made, forming the type called by M. D'Ault Du Mesnil, St. Acheulléen. The surface layer contained objects belonging to the later ages, and does not here concern us. The discussion over the theory of the human origin of these implements soon came to a close by its general acceptance. There have been continuous and almost illimitable discussions over details, but none over the general proposition. 'One swallow does not make a summer,' and a single discovery, either of an implement or a locality, is of slight value in the establishment of any general proposition in prehistoric anthropology. If the discovery of chipped flint implements had been confined to those of Boucher de Perthes, they never would have made any headway. But the attention of those interested in the subject having been attracted to these chipped flint implements, they were, as the polished stone hatchets in the Neolithic period had been previously, found in greater or less numbers in many localities throughout the principal countries of western Europe. Then came a comparison of the same implements from different localities, and it was decided that they were related and formed a stage of culture so different from that of polished stone as to show that they

belonged to another people occupying the country at an earlier date. To this period Sir John Lubbock gave the name Paleolithic.

These chipped flint implements were found by scores of investigators and searchers in hundreds of places, to the number of tens of thousands.

As before remarked, it was the likeness or similarity of the implements, not only in general form, but in the details, as well as in their material, mode of manufacture and possible method of use, which clinched the argument. They so closely resemble each other in the details as to show to the student that the men who made and used them not only belonged all to the same stage of culture, but that either through migration or commerce they must have had intercommunication. They might or might not have been blood-relatives, but that they were really acquaintances and taught each other the modes of fracture of these implements, seems to have been admitted on all hands.

The discoveries of the prehistoric ages of stone have been extended to Africa. Professor H. W. Haynes and General Pitt-Rivers in Egypt and Mr. Seton-Karr in Somaliland, have made discoveries of paleolithic implements. Discoveries of neolithic implements have been made by Mr. J. de Morgan in the valley of the Nile, and by a Belgian, in the valley of the Congo. All have been found in sufficient numbers to establish the fact that they were not isolated or sporadic specimens but were evidence of an extensive human occupation of their locality.

Differences Between Paleolithic and Neolithic Cultures.

In treating of the science of prehistoric anthropology, it is imperative that the differences between the culture of paleolithic and neolithic times should be noticed. Necessarily this must be confined to the Old World, as the discoveries in America have not been sufficient to establish the lines between the two periods.

Mons. Gabriel de Mortillet formulated the differences between his Madelainien epoch (the last of the Paleolithic period) and his Robenhausen epoch (the first of the Neolithic period), and has arranged them in parallel columns that they may make a graphic representation:

LATEST PALEOLITHIC	EARLIEST NEOLITHIC.
(1) Climate cold and dry, with extreme temperatures.	(1) Climate temperate and uniform.
(2) Existence of the last grand fossil species—the mammoth.	(2) The mammoth extinct.
(3) Chamois, marmot, the wild goat in the plains of France.	(3) Chamois, marmot, and wild goat have gone to the summits of the mountains.
(4) Reindeer, saiga (antelope), elk, glutton, white bear, in the center of Europe.	(4) These animals have emigrated toward the Arctic region.
(5) Hyena and the grand cat tribe.	(5) No hyenas or grand cats.
(6) No domestic animals.	(6) Domestic animals abundant.
(7) Human type uniform.	(7) Human type much varied.
(8) Population nomadic.	(8) Population sedentary.
(9) Hunters and fishes, but no agriculture.	(9) Agriculture well developed.
(10) Stone implements always chipped.	(10) Stone implements polished.
(11) No pottery.	(11) Pottery.
(12) No monuments.	(12) Monuments: Dolmens and menhirs.
(13) No burials; no respect for the dead.	(13) Burial of the dead.
(14) No religious ideas.	(14) Religious ideas well developed.
(15) A profound and pure artistic sentiment.	(15) No artistic sentiment.

The radical difference between the Paleolithic and Neolithic periods, and one to be first remarked, was that they were in different geologic epochs. The former belonged to the quaternary, the latter to the present epoch. In the transition from the Paleolithic to the Neolithic the glaciers ceased, the climate became temperate and

uniform, the animals peculiar to the earlier conditions passed away and others affected by the change of climate migrated. There were eighteen species of cold-loving animals in western Europe during the Paleolithic period which migrated to other localities because of the moderation of the temperature incident to the commencement of the Neolithic period. Thirteen of these migrated to cold countries by latitude going to the north, the reindeer, the musk-ox, the blue fox, etc.; five like the chamois and mountain goat, migrated to cold countries by altitude, going up on the mountains.

Comparing the industries of the two periods, we will see some of those of the earlier, continued into the later periods, and some of those the later were invented or improved.

The art of chipping stone into implements was continued from the earlier to the later but to it was added the art of grinding and polishing. All our smoothed and polished stone implements and objects had their origin in this neolithic culture. Sawing and drilling stone began here. The bow and arrow, the first projectile machinery in the world, here had its birth.

The twisting of flaxen thread, weaving and the making of cloth, clothing, commenced in this period. Pottery making was begun which, in itself, wrought a revolution in human culture. The earliest monuments of the world, the great mounds, tumuli, dolmens, menhirs, cromlechs, and the fine specimens of prehistoric architecture, date from this period.

The family was formed, and the clan or tribe organized with a local habitation and a name. Villages, and finally towns were established; animals were domesticated, flocks and herds with farms and pastures came into being; agriculture increased the means of subsistence; a division of labor became fixed, and mechanics with trades were partially inaugurated. Though the neolithic man, from our point of view, was a savage, yet compared with his predecessor, the paleolithic man, he made a long stride towards civilization, whether from savagery to barbarism may be suggested but need not be decided, nor even argued here.

Paleolithic Implements Employed.

The recognition of the artificial character of the chipped flint implements found by Boucher de Perthes, and the many who came after him, and which gave an impetus to the science of prehistoric anthropology, made an opportunity, if it did not create a necessity, for some sort of classification. The Scandinavian classification of stone, bronze and iron had been accepted, but these late discoveries demonstrated an earlier period and called for a subdivision of the age of stone.

All the implements found were of flint and chipped. During this period man did not know how to rub one stone against another to make either of them smooth or sharp, as he did in the later age; so the first was called the chipped stone age, and the other the polished stone age. Sir John Lubbock gave them the names, respectively, Paleolithic and Neolithic. These paleolithic implements of chipped flint being found mostly in the alluvial gravels, the name alluvial, alluvium (French), diluvial, diluvium (English?), were respectively given them.

These implements and the period to which they belong require a description by which they can be recognized from those of other ages. They were all of flint or some chippable material, many of them were made from boulders or concretions. Some were so chipped as to leave the smooth part of the boulder as a grip for the hand. They varied in length from six or eight inches down to three, in width from five to two, and in thickness from three inches to one.

They were generally almond-shaped and had a point or cutting edge at the small end; some of them made from ledge-rock and not from boulders, were brought to an edge all round. In outline they resemble the leaf-shaped implements of later ages; but when viewed edge-wise the difference was manifest in that these were much thicker. The thickness is usually about half their width; an implement four inches wide would be about two inches thick, and one two inches wide, an inch thick, while leaf-shaped implements of that width would not be one-half as thick.

River Drifts, Valleys and Terraces.

A further explanation is as to the formation of the geologic deposits in which the implements were found, and so a decision as to their geologic age. It is believed that at an earlier period in the geology of the country the water of the rivers on its way to the sea eroded the earth (as is shown by the geologic models, principally of the Rocky Mountains, in the U. S. National Museum) and formed valleys, making them reach from one hill to the other and as deep as the present bottom of the rivers; at the second stage the water in the rivers, becoming less in volume and slower in movement, began the process which has been carried on from that day to the present in all river valleys, the cutting or washing of the river bank at or from one point or locality where the water ran swifter and stronger, and carrying it further down the stream where the water ran slower and weaker. In this manner the river terraces were formed, each successive terrace, counting from the hill, represented a corresponding abasement of the water, until, as at present in many of our American rivers, especially the Ohio, three terraces exist on either side of the stream. In the chronologic formation of these terraces, that nearest the hill was the oldest, that nearest the stream the latest. The bottom of each terrace was, naturally, laid down first and, consequently, was older than the top. So the bottom of the first terrace (nearest the hill) was the oldest, and the top of the terrace (that nearest the stream) was the latest.

These paleolithic implements have been found in the bottom of the first terrace and, consequently, were a part of the earliest deposit. And as they continued throughout the various terraces and in the different parts thereof, it is believed that the Paleolithic period in these localities began with the formation of the river-valleys and is coexistent with them.

During all this period no implements of less enduring material than flint have been found, if any ever existed. No human remains have ever been found in the river valleys; nor the remains of any animal so small as man or whose bones were so light and frail as are his.

Differences in Climate.

No traces have been brought to light of either the habitation or the raiment of the man of this period. It has been suggested that he had no need for either. The climate was warm, moist and rainy; he required neither dwelling nor raiment to keep him warm or dry, for, like the savages of warm climates generally he may have preferred to run naked. This is regarded as entirely feasible in the climate then prevailing in western Europe.

But there came a change, supposed to be represented by the glacial epoch, when the climate became cold and wet, and man required protection and so was driven to the caverns for shelter. Here is found the first evidence of raiment. Thus began what has been called the cavern period.

Epochs of the Cavern Period.

Different classifications have been made and different names given to these. Some

of the early scientists named them for the animals of the time and locality. Lartet named them respectively, Cave Bear, Mammoth, Reindeer, and Ox; Dupont, Mammoth and Reindeer. The English generally employed the terms 'river-drift' (for the earlier, paleolith) and 'cavern.' De Mortillet made an exhaustive study and a consequent elaborate classification named for, and based on the industries found in certain localities: The Chelléen after Chelles (Seine-et-Marne), Acheulléen after St. Acheul (Somme), Mousterien after the cavern of Le Moustier (Dordogne), Solutreen after the station of Solutré (Sâone-et-Loire), Madalenien after the rock-shelter of La Madeleine (Dordogne), and Tourassien after La Tourasse (Haute-Garonne), the last representing the hiatus between the Paleolithic and Neolithic ages. This classification was carried throughout the prehistoric ages.

experience will satisfy one of its excellence. Its principle is to give an epoch of culture the name of a locality where that particular culture is manifested in its greatest purity. This may be an arbitrary system, but it has the great desideratum of all systems of nomenclature—certainty and definiteness. By such, one knows exactly what is meant, and this is the chief purpose of nomenclature. The American geologic classification is based largely on the same system.

High-Plateau Paleoliths, Ightham, Kent.

Among many discoveries of paleolithic implements in Europe was a certain class which indicated a human occupation earlier than those found in the river gravels. These belong to the high plateaux between the headwaters of the streams. The principal discovery of implements of this class was by Mr. Benjamin Harrison, of Ightham, Kent; but knowledge of the significance thereof is due to the great geologist, Professor Joseph Prestwich.

Mons. de Mortillet's classification of prehistoric chronology, as applied to France.

TIME.		AGES.	PERIODS.	EPOCHS.
Quaternary—Actual.	Historic.	Iron.	Merovingian.	Wabenien (Waben, Pas-de-Calais).
			Roman.	Champdolien (Champdolent, Seine-et-Oise). Lugdunien (Lyon, Rhone).
	Protohistoric.		Galatian.	Beuvraysien (Mont Beuvray, Nievre). Marnien (Department of Marne). Halstattien (Hallstatt, Austria).
		Bronze.	Tsiganien.	Larnaudien (Larnaud, Jura). Morgien (Morges, canton of Vaud, Switzerland).
Quaternary—Ancient.	Prehistoric.	Stone.	Neolithic.	Robenhausien (Robenhausen, Zurich, Switzerland). Campignyen (Campigny, Seine-Inferieure). Tardenoisien (Fère-en-Tardenois, Aisne).
			Paleolithic.	Tourassien (La Tourasse, Haute-Garonne) Ancient hiatus. Madelainien (La Madeleine, Dordogne). Solutréen (Solutre, Saine-et-Loire). Moustérien (Le Moustier, Dordogne). Archuléen (Saint-Achuel, Somme). Chellèen (Chelles, Seine-et-Marne).
Ter-t'ry.			Eolithic.	Puycournien (Puy-Courny, Cantal). Thenaysien (Thenay, Loire-et-Cher).

Objection may be made to the nomenclature of this classification, but a slight

A small stream runs past the town of Ightham where it joins the Medway. This stream has the usual terraces in its valley which, like other terraces, are formed of river drift. These valleys contained paleolithic implements of the usual kind similar to those heretofore described. The theory was, that the river-valley had been eroded, the sand and gravel cut or washed away, then carried down the stream and deposited where the current became weaker; thus would be involved all the paleolithic implements within the scope of the valley or ravines that fell into it. The information furnished by Mr. Harrison's discovery was that, on the high plateau levels *not* involved in the valleys or the ravines leading to it, the same kind of paleolithic implements were found practically on the surface. The theory of Professor Prestwich founded on Harrison's discovery carries us back one step further in the chronology of paleolithic man. He believed that the implements were made and used by man on these high plateaux before the commencement of the formation of the river-valley; that, being scattered over the surface where they had been left by their owners, they have remained until now found undisturbed, uninfluenced by the erosion, the which as it proceeded, cut away the sand and gravel and drew the the other implements into the valley or into the general current which carried the sand and gravel down, and deposited them with the débris in the form of a terrace. These Harrison implements *not* being within the reach of this erosion, remained *in situ* and are now being found on the surface of the plateau above. Implements, and even workshops indicated by the presence of certain tools and style of implements, remained on the high plateaux and are there found to-day. If they had been within the influence of the stream and had been carried down by its waters, they would have been found in the drift of the terrace below; but not having been thus involved, they were not affected and so remained in their original places until now found. This conclusion, if correct, pushes the paleolithic one epoch farther into the past; instead of the implements being found in the bottom of the river terrace at the completion of their journey, they are found on the high plateau which was originally, and for the others, the beginning of the journey.

Tertiary Man.

Another step in the science of prehistoric anthropology (whether forward or backward is yet to be determined) was the discovery of implements and objects of supposed human origin, or which bore a supposed artificial character, alleged to be evidence of man's existence in the tertiary period. The first report in this direction was by Mons. J. Desnoyers who, on June 8, 1863, presented before the Academy of Sciences at Paris, certain fossil animal bones and pieces of wood, from the quarries of sand and gravel at Saint Prest, near Chartres, France, which were believed to belong to the pliocene formation, whose marks, imprints and striæ were such as could have been made by man and were, therefore, said to be evidence pointing towards his existence in that period. In 1867 the Second Congress of Archeology and Prehistoric Anthropology met at Paris and was largely occupied over a presentation of, and discussion upon the evidences of tertiary man. Mons. L'Abbé Bourgeois presented a series of flint objects which were so chipped or broken as to appear to have been done by man. Other objects were presented by various persons, all alleged to have a bearing upon the main question and tending to establish the existence of man in the tertiary period. These were of different materials: bones cut or marked, teeth or bones drilled, wood and bone carved or gnawed, etc., until a rather

extensive series of objects was gathered and which, if their finders could have successfully maintained, would have gone far toward the establishment of the existence of man in the tertiary period.

Professor Capellini found the fossil rib-bones of a whale in the tertiary deposit at Monte-Aperto, Italy. These ribs had evidently been cut with a sharp knife or tool and might easily have been done by man. There was no attempt at engraving, only certain kerfs across the ribs. Professor Capellini presented his discovery to the Academy of Lincei at Rome, and before the Congresses of Archeology and Prehistoric Anthropology at Budapest in 1876, and at Paris in 1878. I had the pleasure of examining these specimens in the Museum of the University of Bologna, and was much impressed with the contention of Professor Capellini.

Dr. Arturo Issel, one of the leading scientists of Genoa, joined the advocates of tertiary man before the International Congress of Archeology and Prehistoric Anthropology in 1867, by the presentation of a human skeleton, or a portion of one, found at a depth of ten feet in the blue clay, said to have been of pliocene formation, near Savona, Italy. The skeleton was discovered by other persons and had been distributed and portions lost, so that only certain members came to Dr. Issel. There were no other animal bones found in the deposit, but many fossil shells which undoubtedly belonged to the pliocene. If the skeleton was contemporaneous with the original deposit it would be good evidence of the existence of man during that period. Four human skeletons were found at Castenedolo, Italy, by Professor Ragazzoni, then searching for fossil shells. The deposit was determined to belong to the pliocene, or at least to the tertiary.

There were throughout western Europe, perhaps a dozen more instances of objects alleged to be human or related to human, found in tertiary deposits. The principal of these, and that which obtained the greatest prominence, was the discovery of Abbé Bourgeois at Thenay near Pontlevoy (Loire-et-Cher). Among other reasons for the prominence of the discovery of Abbé Bourgeois was the fact that the discovery was near his own residence, where he could give it much of his personal attention; and he was able to attend many or all of the scientific meetings, whether of archeology, geology or paleontology, wherein the subject would find interested auditors, with many opportunities for the presentation of the subject. From the year 1867, when his discovery was presented to the International Congress of Archeology and Prehistoric Anthropology at Paris, until 1883, before the Association Française at Blois, he kept up an aggressive warfare. The deposit at Thenay was agreed to belong to the tertiary, and it had not been disturbed; therefore, if the objects were made by man, they would be evidence of his existence at the time the deposit was made. They were all of flint and had evidently been worked; whether naturally or artifically was the important question. Some had been crackled as though by fire, and others had been chipped as though by man. I have three of these pieces of flint in the Museum at Washington, and am free to confess that, had they been found under conditions ordinarily possible to prehistoric man, I should have no hesitation in accepting them as artificial. The presentation of these flint objects before the various archeological Congresses created great interest and begat much discussion. At one, that in Brussels, an international committee of fifteen members was appointed to investigate the question and make report. The committee divided, as might have been expected. Eight members were of opinion that the pieces of flint were artifically

chipped: DeQuatrefages, Capellini, Worsaae, Englehardt, Augustus W. Franks, Valdemir Schmidt, D'Omalius and Cartailhac;* five members were opposed: Steenstrup, Desor, Neirynck and Fraas; Marquis de Vibray was favorable but with reserve, and Van Beneden unable to decide.

It will thus be perceived that the question was difficult to determine, and much could be said on both sides. If the opposing forces of learned men who, on the ground, marching in the presence of each other and of the objects themselves, and, as at Blois, with the deposit whence the objects came, under their eyes, were still unable to determine the question, it would be venturesome for us to attempt it. Since the meeting at Blois, there has been but little discussion of the flints from Thenay. It would seem as though neither party was convinced by the other, and both were content to maintain their former opinions and cease the discussion. Sir John Evans revived it after a fashion in his presidential address before the British Association at Leeds in 1890, wherein he took opposite grounds.

Discoveries similar to that of the Abbé Bourgeois were made by M. B. Rames, a distinguished geologist of Aurillac, at a locality called Puy Courny near Aurillac; by Charles Ribeiro near Lisbon, Portugal; and by Joseph Bellucci of Perugia, at Otta, Monteredondo, Italy. They all fall into the same category and received the same treatment. In the conclusion to be awarded to the existence of man during the tertiary period, they stand or fall together.

Pithecanthropus—Dubois.

The presentation of this branch of my subject would be incomplete without a reference to the great discovery made by Dr. Dubois at Tinil, Java. Dr. Dubois is an educated physician, a graduate of the Leyden University, interested in prehistoric anthropology, with a sufficient knowledge of geology and paleontology to enable him make satisfactory investigations in the field. He was attached to the Dutch army as a medical officer, and with it sent to Java. He lived there for six years, and having found a deposit of fossil bones at Tinil, prosecuted his researches therein for three summers with great success. During this work he found certain portions of a skeleton which, if not human, was nearer it than was any other. Dr. Dubois has published a preliminary report of his discovery containing a section and plan of the field of his explorations, and photographic copies of the human (?) remains. When this publication appeared and fell into the hands of the physical anthropologists, whether of Europe or of America who, by their knowledge of human and comparative anatomy, were the best qualified to judge, they almost universally settled the question to their own satisfaction in the shortest and easiest way, by the decision that the remains were human and that Dr. Dubois had done nothing more than discover an ancient graveyard. There were few persons in the United States prepared to combat this view. Professor O. C. Marsh visited Leyden in attendance upon the International Congress of Zoology, September, 1895, and upon his return announced that this was a much graver question than had before been recognized.

I had the gratification of visiting Dr. Dubois and seeing his collection. Like Professor Marsh, I was amazed at the showing made. He had, in his laboratory, many thousand pieces of bones from the deposit at Tinil. They were all fossilized, their weight was greatly increased, and their color much darkened, while the human (?) bones had an identical appearance, and it was evident that they came from the

* Mons, Cartailac changed his opinion, but not until several years afterward.

same deposit and were the same age. It is the accepted conclusion on every hand that the bones and deposits belonged to the tertiary period; what particular epoch, I am not prepared to say.

The dilemma presented by the discovery of Dr. Dubois in relation to the antiquity of man is that, if the bones are really those of a human individual, it carries the antiquity of the human species back to the tertiary period. If the individual is not human, because the deposit of the tertiary period is too early, then he must have been the precursor of man and, so the 'missing link.' This dilemma must be recognized and the conclusion made harmonious. Darwin would have accepted this as a representative specimen of his 'missing link.' De Mortillet was of opinion that the animal that chipped the flints of Thenay was not man, but his precursor, which he named 'Anthropopitheque,' or 'Anthropopithecus.' Dr. Dubois has the same idea or theory with regard to the man of his discovery, and he has given it the name 'Pithecanthropus erectus.' The discussion over tertiary man or man's precursor, remains in abeyance. Each of the two parties holds to his respective opinions, *pro* and *con*, and the question awaits further developments.

Neolithic and Bronze Ages Continuous.

If there was a belief in an hiatus between the Paleolithic and the Neolithic ages of Europe, there was no belief in an hiatus between the Neolithic period and the age of Bronze. It seems conceded that there was no appreciable difference in the races of people in western Europe in these two ages. It is also conceded that the stage of culture continued in both practically the same; that all or most of the industries of the Neolithic period were continued into the Bronze age, subject, however, to the natural improvement which came with added experience. The difference between the two ages, then, was the increased facility in performing the function of civilization by reason of having cutting implements of bronze instead of those of stone. The making of bronze was evidently a human invention and has little or nothing to do with a difference in race, nor beyond the benefit or improvement made by the invention, has it much to do with a change in culture.

Copper was easily procured throughout Europe, and implements of that metal were made in neolithic times and doubtless continued to be made in the Bronze age. But the advent of bronze was a totally different affair. Copper did not require casting; it might have been hammered into the desired form and so made into implements, but the knowledge of melting and casting was indispensable to the age of Bronze. Bronze is a mixture of copper and tin in the proportion of eight or nine parts of the former to one of the latter. The question whence came the bronze which was so plentiful throughout Europe has always been one of the problems of prehistoric archeology. The tin necessary for making bronze appears to have come from the country around the Straits of Malacca. The methods of its migration or transportation to Europe, whether the tin was brought over, whether it was melted, mixed with copper and then brought over, both being in the form of ingots, or whether it was cast into implements and then distributed, are facts absolutely unknown, and they probably will always remain so. Prehistoric bronze objects have been found in southern Asia and throughout Europe. The excavations of Dr. Schliemann into the Hill of Hissarlik brought many of them to light. Foundries have been discovered in most European countries; in France nigh a hundred, the latest by Mons. Paul du Chatelier in Brittany. The most extensive one yet found was that at Bologna, Italy. It contained the metal

in all stages of preparation for casting, together with molds and crucibles ready for use. There were (14,000) fourteen thousand pieces of bronze, some in ingots but most of it in wornout implements broken into small pieces suitable for the melting pot.

Epochs of culture in the age of Bronze have been manifested by improvements in style in the hatchets of Southern Europe and the fibulæ of Scandinavia.

Physical Anthropology.

Physical Anthropology, which includes Somatology and Physiology, has received considerable attention at the hands of some of the European anthropologists. Naturally, these sciences are studied at immense disadvantage when confined to prehistoric man, therefore, it has been extended to include savage peoples, and many of the most ardent anthropologists of Europe have studied the somatology and physiology of the savage in the endeavor to obtain even reflected light or knowledge in regard to prehistoric man. There had been a number of skeletons of prehistoric man found throughout western Europe. The instances are rare and isolated where specimens have been found of paleolithic man. The evidence has not always been harmonious, nor has it always pointed in one direction. The Neanderthal skull has been assumed as the representative of the oldest race. Probably a dozen other specimens of human skeletons, or fragments thereof, have been found, all of which are claimed to have belonged to paleolithic man. The following are the best known: Constadt, 1700; Lahr, 1823; Engis, 1833; Denise, 1844; Neanderthal, 1856; Olmo, 1863; Naulette, Furfooz, Solutré, Cro-Magnon, Engischeim, Savona, 1865; Aurignac, Laugerie, Brux, 1872; Mentone, 1872–75; Spy, 1886. Those of the Grotto of Spy, in Belgium, are the best identified and authenticated.

The conclusions to be ventured are, that paleolithic man had a dolichocephalic skull with prominent frontal sinuses; he was short in stature but had heavy bones with strong muscular attachments. He was prognathous, with large and strong projecting teeth which were unusually sound. He had habitually three molar teeth. His legs were crooked, and it has been doubted whether he regularly assumed an upright position.

The human remains found in the caverns, still paleolithic but of the later epochs, indicate an increase in height, size and symmetry. It has been supposed, from comparison of osteologic evidence from the caverns, notably with the Cro-Magnon skeleton, that the Berbers of North Africa and the Guanches of the Canary Islands represent a similar ethnic type.

The neolithic man had a skull more brachycephalic. He was not so prognathous as was paleolithic man; his forehead was higher and squarer, and his brain capacity greater; his teeth were less projecting and not so large as those of paleolithic man. The conditions of human burials in prehistoric times were not advantageous for the present study of the somatology of the individual. The paleolithic man rarely buried his dead, and when he did the preservation and discovery of the skeletons have been largely accidental. The neolithic man buried his dead in great ossuaries and frequently, if not always, subjected the individual to a second burial after the integuments had disappeared. The immediate and direct result is that modern discoveries of these ossuaries find the bones pell-mell, and we are unable to identify those of individuals.

Classification of Races.

Unable to obtain sufficient specimens to enable them to master the science in its relation to prehistoric man, the students of

somatology have, as already suggested, extended their investigations to modern peoples, primitive and savage, hoping for two results: one, incidentally a knowledge of these peoples *per se*, and the other to obtain by comparison a better knowledge of prehistoric peoples. This investigation induced classification of races which have run into infinitesimal details.

There has been much striving among anthropologists for a satisfactory classification of the human race. The item in this classification which seems to have been received with most favor is determined by the cephalic index. This is the ratio between the extreme length of the skull as compared with the extreme breadth, and this compared with the extreme height. Various subdivisions have been made and various names given: dolichocephalic the long-headed; mesocephalic, medium, and brachycephalic, short-headed. Other schemes are according to the character of the hair, running through lophocomi (tufted), eriocomi (fleecy), euplocomi (curly), and euthycomi (straight). Still another classification was that of the dental index by Professor W. H. Flower, the microdont (the lowest index), mesodont (medium), and megadont (the highest dental index).

The earliest and possibly original scheme of classification of the human races was according to color: the yellow, white, black, to which were afterwards added the brown and the red. Probably these stand the test of experience in science about as well as the more complicated classifications.

Dr. Topinard has undertaken an investigation among the people of France by which he is to determine the color of the hair and eyes, segregated according to different departments. Virchow has done the same among the school-children of Germany, and in a late work Dr. W. Z. Ripley, of Columbia University, New York, has reported and published sundry investigations in some of the countries of western Europe, classifying and separating the peoples according to color of skin, hair and eyes, of the cephalic index, of height, and other physical characteristics. Such a work as his applied to the native races of America would be new and original and a valuable contribution to the science of anthropology. Dr. Washington Matthews made such an investigation of the early occupants of the Salado Valley, Arizona.

Darwin's discovery of the origin of the human species by evolution from lower forms of animals, created an interest in the antiquity of man different from that of archeology. It required a knowledge of zoology and of human and comparative anatomy, and involved a study of anthropology in its subdivisions of somatology, physiology and psychology, involving the physical and intellectual characteristics of man. Based upon this necessity, the various schools and societies of anthropology were organized in many of the great cities of the world, notably Paris, London and Berlin.

The organization of these societies and the investigations involved brought to the front a set of scientists totally different from those who had before been studying archeology.

Broca, in Paris, stood near the head of these, followed by Manouvrier and Topinard; Gosse in Geneva, Huxley and Tylor, Biddoe and Keane in England, Virchow and Bastian and Meyer in Germany, with Mantegazza and Sergi in Italy. The family Bertillon, consisting of the father (now dead) and his two sons (successors), were the discoverers and inventors of the science of anthropometry in its adaptation to prehistoric man. The races of men had been studied before, and the general divisions were those of color. Anthropometry gave an additional interest to this branch of the science and it ran riot, making subdivisions on the bases of infinitesimal details. This was pressed to such a point

that one ardent investigator found sufficient difference in the human species as that he subdivided it into 172 races.

Anthropology the Science of Man.

Anthropology was defined to be the science of man, and included everything relating to man, his physical, intellectual, psychologic characteristics; and these extended through all ramifications.

Subdivisions of Anthropology.

Some scientists, chiefly the French, have proposed to confine the term 'Anthropology' to the physical structure, but it is deemed better to include within it everything pertaining to man, making the various subdivisions as represented by the minor sciences, even though they might be treated independently. The following is little more than suggestive :

Biology and comparative anatomy.
- Human anatomy.
  - Anthropometry craniometry.

Comparative psychology.
- Literature, language (written, oral, sign).
- Religious creeds and cults.

Industry.
- Materials and implements of every craft.
- Clothing and personal adornment.
- Habitations, and household utensils.
- Weapons. Pottery.
- Objects for amusement.
- Articles, uses unknown.

Architecture and fine art.
- Monuments and public works.
  - Roads, trails, canals, irrigating, etc.
  - Mounds—sepulchral, effigy, altar.
  - Forts and earth-w'ks.
  - Graves and cemet'ies.
  - Idols and temples.

Architecture and fine art —Continued.
- Cliff or cave dwellings.
- Towers, ruined or otherwise.
- Engraving.
- Painting.
- Sculpture.
- Ceramics.
- Decoration.
- Ornamentation.

Sociology.
- Love and marriage, child-life.
- Social organizations, customs and beliefs, pastimes.
- Tribal organization.
- Government, property, law, etc.
- Mythology, folklore.
- Education, relief and charities.
- Mortuary customs and furniture.

The subdivisions made by the Society of Anthropology of Paris, as set forth in the course of lectures given by its professors during the present year, are as follows : Prehistoric Anthropology, Anthropometry and Embryology, Ethnology, Biology, Language and Ethnography, Sociology (history of civilization), Zoologic Anthropology, Geographic Anthropology, Physical Anthropology.

The Society might not accept the foregoing as a correct or complete subdivision of the science. Other branches may be added on the employment of more professors.

The Society of Anthropology at Washington has, during the past year, made the following rearrangement of sections according to what was deemed proper in matter and terminology :

Section A. Somatology,
" B. Psychology,
" C. Esthetology,
" D. Technology,
" E. Sociology,
" F. Philology,
" G. Sophiology.

It will be understood from the foregoing that the subdivisions cannot be made on hard and fast lines, but are susceptible of infinite changes and varieties. It would be scarcely possible for any one to master all these sciences and so become a perfected and all-round anthropologist. Classification, however, is largely a matter of definition ; the material facts remain the same. The field of any particular science is well-understood, whatever name may be given or to whatever classification it may belong, and it is not worth while to engage in extensive discussion of any particular classification or the nomenclature or terminology of any of these sciences. It is deemed more satisfactory to group them all under the generic name of 'Anthropology.' This plan has been pursued generally in the Societies of Anthropology and in the edu-

cational organizations where it is pretended to be taught.

United States.

It is my duty on this occasion to give some expression to this subject in its relation to America or to the Western Hemisphere. The length of this address precludes an exhaustive examination. The student or reader might, before proceeding further, read the address delivered before this Section, the first by Dr. Daniel G. Brinton* at New York in 1887, the title being 'A Review of the Data for the Study of the Prehistoric Chronology of America'; and the second that of Dr. C. C. Abbott at Cleveland in 1898, the title being 'Evidence of the Antiquity of Man in Eastern North America.'

The conditions under which the beginnings of our knowledge of prehistoric man were made, were quite different in America from those of Europe. In western Europe the historic period began with the invasion of Caesar, fifty or more years before the Christian era, and the prehistoric period with which we have had to deal came to a close about that time.

On the contrary, in America the prehistoric period continued until the discovery of the country by Columbus, and its subsequent occupation by the white man who was thus brought face to face with the prehistoric man. The superstitions, myths and folklore concerning stone hatchets and flint arrow heads so prevalent in western Europe, had no place in America. It was useless to talk to the white man of the heavenly origin of the stone hatchet or the flint arrow head, when he knew by the evidence of his own senses that these were the implements and weapons of the prehistoric savage with which he had to deal.

Thomas Wilson.

U. S. National Museum.

(*To be concluded.*)

* Died at Atlantic City, July 30, 1899. Resolutions of condolence were adopted by Section H at the meeting after the delivery of this address.

CHEMISTRY AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

As has been the custom for several years, the American Chemical Society united with the Section in its meetings, the program on Monday and Tuesday being in charge of the Society and on the other days in charge of the Section. This has resulted very favorably to both parties and never more so than this year when over fifty papers were on the program and the attendance of chemists has been only once if ever surpassed.

The address of the Vice-President, Dr. F. P. Venable, on 'The Definition of the Element,' has already been published in this Journal.

On Monday morning after the adjournment of the general session of the Association, several reports of committees were read. The most important was that of the Committee of the Chemical Society on Coal Analysis. This was presented by W. A. Noyes, the chairman of the committee and was the final report, and took up chiefly the matters of sampling and of moisture. Much discussion was elicited. The reading of papers began on Monday afternoon and continued until Thursday afternoon, when the Section adjourned.

A number of the papers read presented special interest in the field of inorganic chemistry. One of these was by W. R. Whitney on the nature of the change in chromium salts from violet to green on heating. It has of late been quite generally recognized that the chromium salt, say the sulfate, is decomposed on heating its solution into free acid and a more basic salt. The hitherto unsolved problem has been to determine the amount of free acid formed. This Mr. Whitney solved in a very ingenious manner. By enclosing the salt between gelatine walls in a U-tube the acid is made to diffuse, under the influence of an electric current, completely into the jelly,

in which it is easily titrated. The results obtained confirm very completely the correctness of the ordinary accepted theory.

A paper by Louis Kahlenberg, of the University of Wisconsin, on the electrolytic deposition of metals from non-aqueous solutions, dealt primarily with the validity of Faraday's law in such solutions. Experiments with silver nitrate dissolved in pyridin, nitro-benzene, anilin, benzonitril and acetone, and of some other salts in pyridin, show that Faraday's law holds good in these solvents. This is the more striking from the fact that in many other cases non-aqueous solutions do not act like those of water. Kahlenberg also called attention to the fact that from a solution of lead nitrate in pyridin the lead is deposited in bright crystals at the negative pole, while there is no deposit at the positive pole. Silver forms a very dense deposit from solutions of the nitrate in anilin. These latter facts may have some industrial value.

Closely connected with this paper was one by E. C. Franklin, of the University of Kansas, on the electrical conductivity of liquid ammonia solutions, which was a continuation of his work, which has already been noticed in these columns. Professor Franklin described a very ingeniously devised apparatus for purifying the liquid ammonia, particularly from water, and he found that its electric conductivity when thus purified was exceedingly small, not more than one-fourth that of purified water. Many conductivity curves were shown, which resembled more or less closely those of aqueous solutions. Under variable temperature, however, the conductivity increases with the temperature to a maximum and then decreases. This is theoretically the case with aqueous solutions, but the experimental conditions necessary for its demonstration are difficult to obtain.

Note was made in this column a few weeks ago of work which Charles Baskerville, of the University of North Carolina, and others have done on the distribution of titanium. In a paper before the Section, Dr. Baskerville reviewed the work which had been done by others and gave an account of his own work. The most important feature is that every sample of human flesh and bone examined shows the presence of at least traces of titanium. We must consequently consider that titanium is a constant constituent of the human organism, unless, indeed, it militates against Baskerville's work, that only specimens from the negro race were studied. Dr. Baskerville also finds a wide distribution of vanadium, notably in some peats.

A very interesting paper on the relation of physical chemistry to technical chemistry was read by Wilder D. Bancroft, of Cornell, and a most carefully prepared lecture on 'Some Experimental Illustrations of the Electrolytic Dissociation Theory,' was delivered by Arthur A. Noyes, of the Institute of Technology. A word should be added in commendation not alone of the lecture, but also of the idea of having such lectures. It is now the custom of the London Chemical Society to have its annual lecture, and of the German Chemical Society to have them more frequently. The delivery of one or two such lectures before the chemical section, by experts, on subjects about which every chemist wishes to be informed, while few are, would prove one of the most profitable features of the meeting, and it is to be hoped it will be repeated in the future.

Several papers in other fields than that of inorganic chemistry may be noticed. One of the most interesting of these was by H. W. Wiley and W. H. Krug on 'Some New Products of Maize Stalks.' It would have surprised a farmer to see the great variety of materials of which Dr. Wiley showed samples, all made from cornstalks. There was cellulose pith which is now extensively used on war vessels as a backing to armor

plate, from the fact that if pierced by a shot, the cellulose immediately swells and fills the hole, preventing the passage of water; chicken feed and cattle feed of various qualities, one variety containing a large quantity of molasses, and solving the problem of feeding molasses to stock; paper pulp and samples of paper of excellent quality made from it; nitroglycerin absorbents of different grades, giving different qualities of dynamite; superior qualities of nitrocellulose, some for the manufacture of smokeless powder, while from others excellent collodion is formed. Putting this paper with one by C. G. Hopkins on 'Improvement in the Chemical Composition of the Corn Kernel,' one recognizes that not only is corn raising the great American industry, but we to-day far from realize what will be the future importance of this crop. In a paper by M. Gomberg on 'Diazo-caffein,' the intense coloring power of the substance was noted. In another by the same author on the 'Preparation of Tri-phenylchlormethane and Tri-phenylcarbinol,' the synthesis by the use of aluminum chlorid was considered. For the preparation of the aluminum chlorid the author prefers to pass chlorin over hot aluminum, and this is far simpler than the method in which hydrochloric acid is used.

Professor W. A. Noyes contributed a paper on camphoric acid which added materially to our knowledge of this substance, and Professor W. McPherson gave the abstract of an interesting paper on the constitution of oxy-azo-compounds.

Professor H. A. Weber described the method of testing soils for application of commercial fertilizers, in use at the Ohio State University. It consists essentially in taking several samples of the soil, treating them respectively with potash, phosphoric acid and nitrogen, singly and in combination, sowing each with several seeds and basing opinions on the growth of the plants produced.

The estimation of carbon monoxid was considered by L. P. Kinnicutt and G. R. Sanford. In view of the fact that 0.05% of carbon monoxid in the air is dangerous, its detection and estimation is important. The absorption of carbon monoxid by hemaglobin is largely used, but the authors have found better the oxidation of carbon monoxid to the dioxid by hot iodic acid and subsequent titration by sodium thiosulfate.

A paper by Professor T. W. Richards on the atomic weight of calcium gave as the most correct figure at present 40.14.

Although not strictly pertaining to chemistry, mention should be made of the Commers tendered Section C by the Humboldt Verein, of which Professor H. A. Weber is president. The Verein, the Section and quite a number of other invited guests spent the evening enjoying the sumptuous hospitality of their hosts, expressed in thoroughly German style.

A list of the papers upon the program of the Section is appended.

The Nature of the Change from Violet to Green in Solution of Chromium Salts. W. R. Whitney.

Micro-structure of Antimony-tin Alloys. J. J. Kessler, Jr.

The Relation of Physical Chemistry to Technical Chemistry. W. D. Bancroft.

Methods of Analysis of Sulfite Solutions as used in Paper Making. R. de Roode.

The Electrolytic Deposition of Metals from Non-aqueous Solutions. L. Kahlenberg.

Some Experimental Illustrations of the Electrolytic Dissociation Theory (An experimental lecture.) A. A. Noyes.

Improvement in the Chemical Composition of the Corn Kernel. C. G. Hopkins.

Some New Products of the Maize Stalks. H. W. Wiley and W. H. Krug.

Soil Humus. E. F. Ladd.

The Relation of Fertilizers to Soil Moisture. J. T. Willard.

Secondary Heptylamin. T. Clark.

Propane Trisulfonic Acid. W. B. Shober.

Camphoric Acid, Alpha-hydroxy-dihydro-cis-campholytic Acid, and the Synthesis of Dimethyl-cyan-carbon-ethyl-cyclo-pentanone. W. A. Noyes and J. W. Shepherd.

Diazo-Caffein. M. Gomberg.

The Preparation of Tri-phenyl-chlor-methane and Triphenyl-carbinol. M. Gomberg.

The Action of Sodium Methylate upon the Dibromids of Propenyl Compounds and Unsaturated Ketones. F. J. Pond.

Some Secondary Cyclic Amins. C. C. Howard.

On the Constitution of the Oxy-azo-Compounds. W. McPherson.

On Naphthalene-azo-alpha-naphthol and its Derivatives. W. McPherson and R. Fischer.

Esterification Experiments with Hexahydro- and Tetrahydroxylic Acids. W. A. Noyes.

On the Condensation of Chloral with Ortho-, Meta- and Paranitranilins. C. Baskerville.

A Pneumatic System for Preventing the Bursting of Waterpipes through Freezing. N. M. Hopkins.

Note on the Occurrence of Chromium, Titanium and Vanadium in Peats. C. Baskerville.

On the Universal Distribution of Titanium. C. Baskerville.

The Atomic Weight of Calcium. T. W. Richards.

The Iodometric Determination of Small Quantities of Carbon Monoxid. L. P. Kinnicutt and G. R. Sanford.

Preliminary Report on a New Method for the Determination of Carbon Dioxid. M. E. Hiltner.

Analysis of Oils. A. H. Gill.

Examination of Lemon Flavoring Extracts. A. S. Mitchell.

The Composition of American and Foreign Dairy Salt. F. W. Woll.

Notes on Testing Soils for Application of Commercial Fertilizers. H. A. Weber.

The Electrical Conductivity of Liquid Ammonia Solutions. E. C. Franklin and C. A. Kraus.

A Determination of the Transformation Point of Sodium Sulfate. A. P. Saunders.

On the Derivatives of Isuretinic and Formhydroxamic Acid and their Relation to Fulminic Acid. H. C. Biddle.

The Reichert Figure of Butter. J. H. Stebbins, Jr.

The Determination of Nickel in Nickel Steel. G. W. Sargent.

Notes on the Estimation of Total Carbon in Iron and Steel. F. P. Dunnington.

Electrolysis of Metallic Phosphate Solutions. H. M. Fernberger and E. F. Smith.

On the Determination of Volatile Combustible Matter in Coke and Anthracite Coal. R. K. Meade and J. C. Atkins.

Observations upon Tungsten. E. F. Smith.

The Atomic Mass of Tungsten. W. L. Hardin.

Notes on the Determination of Sulfur in Pig Iron. M. J. Moore.

The Chemistry of Rancidity in Butter Fat. C. A. Browne, Jr.

An Electrolytic Study of Benzoin and Benzil. J. H. James.

The Quantitative Estimation of Boric Acid in Tourmaline. G. W. Sargent.

Some Boiling Point Curves. J. K. Haywood.

Electrolytic Determinations and Separations. L. G. Kollack.

The Precipitation of Copper by Zinc. J. G. Shengle and E. F. Smith.

Derivatives and Atomic Mass of Palladium. W. L. Hardin.

Action of Hydrochloric Acid Gas upon Sulfates, Selenates, Tellurates and Phosphates. R. W. Tunnell and E. F. Smith.

The Electrolytic Oxidation of Succinic Acid. C. H. Clarke and E. F. Smith.

The Persulfates of Rubidium, Cesium and Thallium. A. R. Foster and E. F. Smith.

The Chemical Composition of Butter Fat. C. A. Browne, Jr.

Halids and Perhalids of the Picolins. P. Murrill.

JAS. LEWIS HOWE.
WASHINGTON AND LEE UNIVERSITY.

THE COLLECTIONS OF NATURAL HISTORY AT SOUTH KENSINGTON.*

THE collections in the Natural History Museum at South Kensington have recently been considerably enriched by means of exploring expeditions which have brought home from various parts of the world collections of great scientific interest and value. The late Sir William Flower did much to encourage scientific studies on the part of travellers in remote countries, and he was always ready to coöperate in the organization of expeditions and in giving official aid in the determination of collections brought home by explorers. His successor at the Museum, Professor Ray Lankester has lost no time in evincing his complete accord with the ideas of his predecessor in this respect, and indeed it is already evident that he favors a great development of this policy. The fact is becoming more and more generally recognized that it is the business of a national museum of natural history not merely to preserve for scientific study and public instruction the specimens acquired by presentation or by purchase from dealers and others, but to obtain objects by the deliberate exploration of regions which are likely to yield rich harvests of new and important material. This idea has, we are glad to note, been encouraged by the authorities of the Museum. It is seldom now that an important expedition organized by private enterprise leaves these shores without either the explorer himself being in a measure instructed as to the best means of obtaining specimens and supplied with the necessary apparatus for collecting or taking with him one or more trained naturalists.

The natural history branch of the British Museum benefited greatly by the results of the expedition to Sokotra, which, under the liberal auspices of the Royal and Royal Geographical Societies and of the British Association, was organized by Mr. W. R. Ogilvie-Grant, representing the British Museum, and Dr. H. O. Forbes, director of the Liverpool Museum, with the generous aid of the committee of that institution, for the purpose of investigating and making collections of the natural history of that island. Dr. Forbes will, we believe, give an account of the geographical results of this expedition in Section E at the forthcoming meeting of the British Association at Dover. As regards its zoological work, which was its main object, the general results can be described as most successful. Sokotra does not seem to be rich in its mammal fauna. Only one mammal was recorded from it before Messrs. Forbes and Grant explored the island. They, however, obtained eight distinct species, including a wild ass, goat, Arabian hare, rat, two species of bat, and the Arabian baboon, of which two living examples were brought to England for the Zoological Gardens. The avifauna is very rich, as many as 62 species, represented by nearly 600 specimens, being secured. Eight of the species were new to science. Twenty-three species of reptiles, represented by 350 specimens, 8 of the species being new; 20 species of marine fish, represented by nearly 60 specimens, and large collections of land shells and insects containing many undescribed forms were also included in the harvest. The butterflies are especially numerous, several of the species being very beautiful and hitherto unrecorded.

*From the London *Times*.

Another expedition which has yielded results of considerable geological and zoological interest is that undertaken this summer by Dr. J. W. Gregory, of the Department of Geology, to the West Indies, special leave of absence being granted to him by the trustees. The particular object of Dr. Gregory's journey was the examination of the geology of the island of Antigua, but in the course of his voyage he visited such little-explored and out-of-the-way islands as Anguilla, Barbuda, and St. Kitts. The first-named was once a flourishing British colony, but is now derelict by whites. During his stay on this islet Dr. Gregory made a collection of fossils and of the fauna of the place which promises to be of remarkable interest and quite new to the Museum. He also brought back a very large series of specimens from other West Indian islands, and obtained *data* which will enable him to make an important contribution to our knowledge of their geological history.

The Museum availed itself of the opportunity of making some acquisitions of particular interest by means of the expedition sent out by the Hon. Walter Rothschild to the Galapagos Archipelago, off the coast of Ecuador. The fauna of these islands is a rapidly expiring one. Many of the species of birds discovered by Darwin during the voyage of the Beagle, no longer exist, having been exterminated by the convicts who, to the number of about 200, are sent to work on the Galapagos. The giant tortoises peculiar to the group have almost disappeared. Dr. Günther has told us that at the time of the discovery of this archipelago, in the 16th century, the tortoises were distributed in immense numbers over most of the islands ; they are now restricted to three only—Albemarle, Duncan, and Abingdon. A search in which four persons were engaged for ten days, rewarded Dr. Baur, who visited Albemarle, the largest island of the group, in 1891, with the capture of five adult specimens. The Museum obtained four very fine examples of this interesting and rapidly diminishing type of *Chelonian*, generally known as 'gigantic land tortoises,' besides a series of five hundred birds and a large collection of reptiles as its share of part of the results of the Rothschild expedition.

The ornithological section has just been enriched through the generosity of Mr. Weld Blundell and Lord Lovat, who have presented to the trustees the very fine collection of birds made by them during their recent adventurous journey in Abyssinia. In the course of their travels through the Galla country and Southern Abyssinia they passed over about 300 miles of country which had never been previously explored. The collection, which consists of 530 specimens, has not yet been thoroughly examined, but the ornithologists of the Museum, Dr. Bowdler Sharpe and Mr. Ogilvie-Grant, are already convinced that it is of very great interest. It includes 234 species, at least 18 being either new to science or not represented in the Museum series. The remarkable feature of this collection of Abyssinian birds in the extraordinary number of species obtained as compared with the number of specimens—a fact which says much for the discrimination of the explorers, who, being handicapped by want of cartridges, had to be cautious in not wasting shots. An idea of the prolificness of the country in bird life may be gathered when it is stated that on entering a new valley the two travelers, having already obtained over 200 species, secured a starling, two small finches, a kingfisher, a reed-warbler, a swallow, and a weaver, all new to their collection and six of the birds not even seen before. The value of the gift is much enhanced by the perfect manner in which the skins were prepared for the cabinet. Credit for this must be given to

Mr. Harwood, the taxidermist who accompanied the expedition and by his work materially assisted Mr. Weld Blundell and Lord Lovat in forming so fine a series of birds.

The mission despatched to Sierra Leone by the Liverpool School of Tropical Diseases for the investigation of malaria may be expected to send home some interesting specimens. Mr. E. E. Austen, the dipterologist of the British Museum, is a member of the party. He will, of course, give most attention to the special objects of the mission—the connection of malaria with mosquitoes—but, besides collecting these winged insects and acquiring valuable knowledge as to their habits and life histories, he will endeavor, as far as possible, to make collections of other groups, some of which are very incompletely represented in the Museum. With reference to this question of mosquitoes and malaria it may be added that, owing to the official steps taken by the Colonial Office, the Foreign Office, the India Office, and the missionary societies, the British Museum will soon be in possession of a unique collection of these insects. As a result of the official circular issued on the subject, hundreds of mosquitoes have, we are informed, already arrived at the Museum from every part of the British Empire, and these are belived to be only a very small portion of the consignments which are to follow in course of time.

SOME NEW DATA FOR CONVERTING GEOLOGICAL TIME INTO YEARS.

WHILE conducting the Union Pacific Expedition through central Wyoming last August, I came upon what appears to be some valuable data for converting geological time into years. For a number of days we were encamped on the rim of Bates' Hole, near Lone Tree Cr., and studied the Miocene beds, which are quite extensive in that region. Bates' Hole is a vast depression produced by the erosion of Tertiary beds and varies from six to twelve miles in width, and approximates twenty miles in length. In depth it varies from 500 to 1500 feet below the rim, and is one vast expanse of rough and broken country, surrounded by bluffs so precipitous that up to this late date there has been but a single wagon road made to enter it from the southern end; and this is far from being ideal. The bluffs that surround this very singular depression take on all of the peculiar erosion topography seen in the 'Bad Lands' elsewhere, and in many respects surpasses any of the 'Bad Land' scenery yet described. The Miocene beds are made of whitish bands chiefly and in the vicinity of Lone Tree Cr., there are many slopes of about 30° reaching upwards from the valley, and above them terrace after terrace of harder bands that represent the castle like erosion. The slopes, as well as in many places the bluffs, are partially covered with pine trees (*Pinus murryana* Eng.). The trees on the slopes are stunted, gnarly and knotty, and are strongly marked by their great struggle for existence under the most unfavorable conditions. The oldest of these trees vary in diameter from eighteen inches to two feet, and have been recording the rate of erosion on these slopes for about 300 years.

Erosion has been so rapid that the oldest trees are now standing upon their stilt-like roots, with their trunks elevated from the slope some three or four feet. The rate of erosion appears to have been uniform with the growth of the trees. The trunk of the sapling remained on the ground; while the trunk of a tree six inches in diameter was often several inches above the surface, and the tree a foot in diameter was already upon stilts. On account of the shortness of our stay, absolute measurements of a large number of trees could not be made. Nor

could the exact age of a number of trees be determined. This has been planned for future work and will be executed at the earliest possible date. The fact, however, that these trees have acted as silent guards for centuries over these slopes and have recorded with unerring accuracy the rate of erosion is apparent, and as soon as the data can be secured, there will be a valuable factor for converting geological time into years.

By approximating the various estimates in connection with the date the following may be of interest: The Hole where the observations were made was about six miles wide. The trees were 300 years old and there had been on an average of three feet of rock removed from their roots. This would require one hundred years to remove a foot of the formation. Considering that the erosion started in the center of the Hole, there has been three miles removed from either side, which at the rate of one foot per century would require 1,584,000 years. Without question this erosion commenced at the close of the Miocene and hence represents the entire Pliocene and Pleistocene Epochs. The exact time relation of the Pliocene, and Pleistocene in relation to Eocene and Miocene has not been established; but if the Pliocene and Pleistocene Epochs represent 1,584,000 years it would not be out of the way to estimate Cenozoic time at 4,000,000 years. If this value be substituted in the ratios of geological time suggested by Dana:—Paleozoic: Mesozoic: Cenozoic as 12 : 3 : 1 then all geological time since the beginning of the Cambrian would be represented by 64,000,000 years. This estimate is not inconsistent with some already made; but when founded on absolute data may vary much from this. Nevertheless, whatever the results may be when found upon a complete investigation of this subject, they will furnish valuable scientific data that will aid materially in giving us a better understanding of geological time in terms of years.

Wilbur C. Knight.

Geological Laboratory
University of Wyoming,
October 2, 1899.

SCIENTIFIC BOOKS.

La géologie expérimentale. Par Stanislas Meunier, Professeur de Géologie au Museum d'histoire naturelle de Paris. With 56 figures in the text. Paris, Ancienne librairie, Germer Baillière et cie. 1899. Pp. 311. (Bibliothèque Scientifique Internationale, XCII.). Price, 6 frs.

Just twenty years have elapsed since Daubrée brought out his famous work *Études synthétiques de géologie expérimentale,* and laid thereby the foundations of the school of French experimentalists. This book was translated into German in the following year, 1880, but never found an English interpreter. That such an edition was needed is shown by the reference in Dana's Manual of Geology to an alleged experiment of Daubrée with plates of *ice*, which should have been rendered plates of *glass*.

The mantle of Daubrée seems to have been taken up by M. Stanislas Meunier, who enjoys the distinction of having reduced the odds and ends of experiments, performed in the imitation and illustration of geologic processes, to a system of lectures for the entertainment and instruction of a large class of students. The present book is a *résumé* of these lectures as given in the year 1898 at the Museum of Natural History in Paris.

The scope of the work is general, in that the experiments described relate to a wide range of phenomena, *e. g.*, the formation of rainprints, stream channels, deltas, solution furrows, weathering, disintegration and decomposition of rocks, the striation of rocks, sedimentation under varied conditions, the production of faults, folds, and systems of fracture and displacement. The treatment of the subject, however, is somewhat narrowed by the fact that the author deals almost altogether with his own experiments, with only incidental reference to the work of others. The book cannot be said, therefore, to represent fairly or comprehen-

sively the state of experimental geology. The critical student to whom experiments are the last resort will find from footnotes that most of the author's tests are more completely described in the *Comptes rendus de l'Academie des Sciences.*

The grouping of the subject matter is good, experiments relating to epigene processes coming first and those pertaining to the theory of hypogene actions following. An introductory chapter of 34 pages is an apology for and defense of 'La Geologie experimentale,' a frank statement that the methods and its results are scorned in certain quarters. While this admission seems not inappropriate, the frequent references in the body of the work to the distinction between experimental geology and geology as ordinarily pursued, appear somewhat pathetic and out of place in a book designedly published in the interests of science and for the popularization of this subject. Notwithstanding the fact that many of the author's attempted explanations of natural phenomena would probably not be accepted by geologists, it cannot but be instructive to many who have not grasped the facts of the earth's structure to see how by some simple mechanical contrivance phenomena simulating mountains, the action of volcanoes, the effects of earthquakes and the like may be produced. However far removed the apparatus employed may be from the exact processes in nature, analogies described in the text must displace much misconception which prevails in the popular mind concerning the operations of the earth forces.

It is to be regretted that the author did not state the principles governing experimentation and something of the limitations of the method. Though the objections to certain experiments are briefly referred to, there is much which has been said on the subject of which we find no echo in this book. A text-book giving a comprehensive view of the subject with critical notes would be a welcome addition to our geological laboratories.

As for the experiments, many of them illustrate everyday changes which it is customary in all favorably situated colleges to demonstrate in the field where the natural process and its product may be seen under more favorable circumstances than in the laboratory. That experimentation without accurate knowledge of the facts to be explained is not infallible, is well illustrated by the different conclusions reached by Daubrée and Meunier in regard to the rectangular courses of rivers. Daubrée, it will be recalled, sought to explain the right-angled courses of streams by postulating preëxistent faults as guiding lines for the drainage. At the time he did his work this explanation had many adherents. It is manifestly no difficult matter for a clever artisan to devise a model in which the conditions of the hypothesis and the expected results are satisfactorily demonstrated. Professor Meunier, evidently familiar with the current view that such rectangular courses arise in the development of a river system upon certain geological structures unaffected by faults, performs an experiment through which he comes to disbelieve in Daubrée's conclusion. Incidentally the phenomena of the headwater gnawing of streams, the recession of falls, and river-capture, are artificially reproduced. It is to be noted that in the discussion the reference to 35,000 years as the time required for the recession of Niagara Falls indicates an oversight on the part of the author of all recent investigations on that subject.

Some of the experiments intended to illustrate the phenomena of meanders in streams seem hardly legitimate, or at least there is no endeavor to imitate nature in the employment of a stream of mercury and in the production of meanders on a slope of 20 degrees! The object of the experiment seems here to have been lost sight of! Likewise the agitation of a flexible cord, substituted for a stream with meanders, in the attempt to illustrate the control of the meander is amusing, but it may be questioned whether it is convincing.

Other experiments are described as designed to prove the competency of running water to excavate valleys and with the further purpose of combating the lingering notion in France that 'we are now in a period of geologic tranquility.'

Under the head of marine and lacustrine denudation, M. Stanislas Meunier treats of the mechanical action of waves and the chemical action of water. The experiments with wave

action are seemingly very incomplete in that no mention is made of the formation of shore-bars, spits, hooks, etc. It seems likely that the scalloped beaches described by Jefferson (*Journal of Geology*, Chicago, VII., 1899), might have light thrown on their origin by proper experimentation.

"Glacial geology offers an extended field for experiments, and in this connection our author proceeds to imitate the formation of crevasses, employing stearin placed on a band of rubber. Tension is applied and crevasses are formed. To demonstrate glacial erosion by the striation of rock fragments, the simple friction experiment of Daubrée and others is repeated. It should be said that this experiment does not offer a very close analogy to the conditions in a glacier on account of the 'plasticity' of ice. But it is in regard to recurrent occupation of a field by glaciers that M. Stanislas Meunier makes his most novel suggestion. His proposition may be given in nearly his own words:

"Given a glacier, and everything else remaining in equilibrium, it tends to diminish in spite of seasonable changes, by reason of the progressive lowering of its basin of supply [because] the materials which it transports in such great quantities along with the water which is associated with it, reduce the relief of the ground. It then recedes, and behind its abandoned frontal moraine vegetation is established. But, comparable at all points with rivers, it gnaws back progressively at its head, and it is possible for this recession to reach the point by destroying the rocky arête which separates its basin from that of a neighboring glacier, where it is permitted to divert this glacier to its own basin. Thereupon an increase of substance ought to provoke a return to the dimensions formerly held, and from that time the products of the fossilization of the plants established upon the first glacial terrane will be covered with a second morainal extension."

It is our author's view that this phenomenon of capture of glaciers by being reciprocal and recurrent, accounts for the so-called successive glacial periods in the Pleistocene. He necessarily attempts to refute the theory that these epochs of glaciation and deglaciation are 'general and simultaneous.' While the oscillations of glaciers in a region of valleys such as the Alps might very plausibly be affected by changes of this kind, it is not so apparent that the broad marginal oscillations of the ice-sheet of North America, for instance, can be explained in this manner.

We next find a brief chapter on the work of underground water. Several simple and readily devised means are adopted for imitating the leading features in the production of water-worn channels, tunnels and the striation of pebbles *en masse* through movements initiated by the washing out of supporting materials. The author indulges in some animadversions upon the nature of the scratched drift of the pre-alps of Europe and holds to the opinion that much of the so-called glacial drift of that region is really material striated in mud-flows—of which subject there is more to follow.

Eolian denudation is passed over with a few references to the geological work of the winds and to the well-known experiments of Thoulet. The term *abrasion* employed in a technical sense for wind erosion has not so extended a use among English-speaking writers as the author evidently thinks. Walther's term *deflation* is the only one apparently commanding anything like general use.

The processes of sedimentation receive a well-deserved attention. In this connection the author devotes several pages to the subject of mud-flows, a feature of many moist mountain regions which has been given evidently too little attention by geologists, but which is hardly so important a factor as the author intimates. There are a number of experiments described to show the rate of falling particles in water; and small points bearing on the criteria of horizontality in the deposition of certain strata are brought out. None of these precautions, however, appear to have escaped the attention of field geologists and the author here, as elsewhere, seems to have been forestalled in many of his discoveries. The statement that floating trees in large rivers sink root downward and thus may be buried upright giving the appearance of buried forests appears to pertain to observational geology. There are experiments to show the amount of water included in sediments. A frequent defect of the book is the

mere reference to experiments which are not described, as, for instance, in the case of deltas. The deposition of sediments in the subterrane is treated experimentally and chemical alterations inducing color bands are imitated.

M. Stanislas Meunier has successfully reproduced fossil footprints by blowing sand upon the tracked surface covered with a slight depth of water. He conceives, therefore, that fossil footprints cannot have been preserved by the rise of water spreading sand over the surface on which tracks were made. It remains for some clever manipulator to prove the converse of this proposition as equally effective. The author's point is a good one, however, and the numerous instances in the older strata in which mud-tracked surfaces are covered with sand is a strong argument in favor of his theory.

Dessication of strata and their torsion are next taken up. The author concludes from his experiments that regular rhomboidal jointing is not to be explained by torsion as Daubrée labored to prove. Neither Daubrée nor the author have imitated with any degree of accuracy the conditions in which the stratum is placed when it yields to the jointing strain, and critical experiments are much needed in the elucidation of an old but not yet satisfactorily solved problem.

A very brief reference to the origin of the crystalline rocks deals mainly with the work of Messrs. Fouqué and Lévy on the igneous rocks. An even shorter discussion of metamorphism touches only some of the concomitants of metamorphism, such as the carbonization of wood tissue. The experiments of Sénarmont and a few others are referred to in the explanation of metalliferous veins, and a few words are given on the subject of kaolinization and serpentinization.

Our author now plunges boldly into experiments designed to elucidate the origin of the primitive crust of the globe. He assumes that beneath the *débris* of the surface there exists a granitic zone, under which occurs a shell of which silica, magnesia and iron constitute the greater part, citing, as evidence of this latter rock, dunite, and the dolerite with native iron at Ovifak. This shell is supposed to have been formed by a precipitation from the nebular gas. The author has obtained in a porcelain tube the synthesis of the principal silicates of magnesia without the intervention of fusion in illustration of this conception. He concludes from his experiments that the solid shell of the globe which was first formed and which had analogies with the solar photosphere, consists of magnesium silicate rocks with an abundance of metallic concretions of which the genesis is related to the phenomena still evident in the material of tin-bearing veins and even in the chimneys of volcanoes. There results, he goes on to state, a relative distribution, in which the consideration of the density of the bodies studied at ordinary temperatures plays no part. Metallic iron, for instance, no "longer appears as constituting a massive nucleus, but on the contrary as forming a true shell below which have been congealed in later times the rocks of which eruptions have procured for us specimens in every geologic epoch."

In part second of this book over 50 pages are devoted to the application of the experimental method to the problems of deep-seated mechanical action. The remarks on the effects of weight or gravity appear not to be suggested by experiments, but to have risen out of the general philosophy of geology. Indented pebbles are ascribed to pure pressure without chemical solution.

An experiment is described with the design of showing the supposed effects of the centrifugal force upon the original crust of the earth. The substances employed in a rotating glass bottle of spherical shape arrange themselves about the equator in the inverse order of their densities contrary to what would be expected from gravity alone. This experiment is largely relied upon for some of the conclusions previously stated regarding the nucleus of the earth.

An experiment to illustrate the formation of volcanic cones reproduces such little burst steam bubbles as one sees in the paint-pots of the Yellowstone Park. Laccoliths are also, it is stated, reproducible by means of melted wax injected between sheets of plaster having a slight degree of plasticity.

Professor Meunier attempts also the famous problem of introducing water into the interior

of the earth, in short, into his infra-granite zone. He holds that the water which comes out in volcanoes cannot be original, because the temperature of the globe is constantly decreasing and that past conditions were still less favorable than the present ones for the maintenance of water in the interior. He thinks, therefore, that the water is of recent introduction.

"The solution of the question," states our author, "appears to result from some very simple experiments of M. Stanislas Meunier." Without describing the experiment which in no way duplicates the condition of the earth's crust at a depth, the author supposes that the water is brought into the infra-granitic zone as water of consolidation and crystallization embodied in fragments of rock which fall down along fault-planes and zones of crushing. The 'falling' of these hydrated rocks into the heated regions of the globe is supposed to give rise to volcanic explosions and as is stated in the next chapter to earthquakes also. The author very frankly states that he is obliged to note the profound astonishment which the first publication of his views elicited.

In the experiments on folds some interesting points are dwelt upon concerning the intersection of planes of fracture which arise, but these artificial faults are not compared with those of any particular region. Under the head of schistosity are described experiments which appear in reality to have induced a kind of cleavage as that term is understood in English. Fractures are produced by compression in some experiments which lead the author to reject Daubrée's famous radiating fractures produced by torsion, seemingly on the ground that such fractures have 'not anywhere been observed.'

The general distribution of mountains upon the globe last of all comes in for experimentation in the clever methods of the author. A small hemispherical shell has stretched over it a rubber layer coated with plaster, in such a manner that when the foundation, which represents the contracting nucleus of the globe, is allowed to retreat, the contraction of the rubber layer induces compression of the plaster. This stress is relieved by circumpolar lines of shearing and displacement, the overthrust being poleward in direction. The author points out the analogies which seem to exist between this model and the arrangement and orogenic movements of the mountain systems of Europe. The researches of Suess on the northwesterly movement of the Eurasian thrusts should be noted as favoring this hypothesis, but it is difficult to see in what way the view is exemplified on the North American continent.

The book is closed with a 'Postface' or statement, with which most geologists will probably agree, that this volume sets forth facts amply sufficing to justify the *raison d'être* of experimental geology. Whatever misgivings one may entertain concerning the decisive character of some of the experiments, there can be no doubt of the suggestiveness of the original and ingenious methods which the author has brought to bear upon some of the largest questions of dynamical geology. The book is illustrated with a few good cuts and is well printed. A list of contents takes the place of a good index. The publishers have taken the liberty of appending 35 pages of advertising matter which might have been omitted.

J. B. W.

Leçons sur la détermination des orbites professées à la Faculté des Sciences de Paris. Par F. TISSERAND; redigées et développées pour les calculs numériques par J. PERCHOT; avec une préface de H. POINCARÉ. Paris, Gauthier-Villars. 1899. 4to. Pp. xiv + 124.

These lectures formed a part of the course in mathematical astronomy delivered at the Sorbonne by the late Professor Tisserand, but the important question of the determination of cometary and planetary orbits was not treated in his well-known treatise on celestial mechanics. The only work in the French language devoted to the numerical elements of orbits is the translation of Oppolzer's treatise, which is a most useful book to the computer, but neither easy nor attractive to the reader; on the contrary the lectures of Tisserand exhibit the clearness of exposition and the simplicity and elegance of method which uniformly characterize his writings, so that all devotees of mathematical science will be indebted to M. Perchot for this edition of the unedited lectures of his lamented master. Professor Poincaré's pre-

face, the most interesting chapter of the volume, is a graceful memorial to his predecessor at the Sorbonne; it discusses the methods of Laplace, Gauss and Olbers, together with other possibilities in the determination of orbits, and concludes with a concise *résumé* of the method followed in Tisserand's exposition.

In the first chapter Tisserand presents the method of Olbers for the determination of parabolic orbits. By this method the calculations fall into two parts: 1°. No hypothesis is made as to the nature of the orbit, and the six equations are combined in such a manner as to yield a unique equation; this combination can be made in an infinite number of ways and thus yield an infinite number of equations; Olbers effected it in such a happy manner that the unique equation assumes a remarkably simple form whose simplicity is conserved in the second approximation if the observations are equidistant. 2°. In the second part the condition for a parabolic orbit is introduced, thus reducing the number of unknowns to five: to the four equations given by the two extreme observations is joined the unique equation obtained in the first part. Four equations in four unknowns are to be solved; resort must be had to successive approximation. The chief advantage of Olber's method is that the only equations which present difficulties of computation contain only two unknowns; tables of single entry give one of these as functions of the other.

The second chapter presents the well-known method of Gauss for the determination of the orbit of a planet from three observations elaborated in his *Theoria motus*.

M. Perchot has increased the usefulness and convenience of the book by appending general *résumés* of the formulæ in definitive form for computing together with the numerical calculation of the orbit of the asteroid, 1897, DJ., in which no detail has been omitted; this model computation and reproductions of Oppolzer's tables VIII. and IX. conclude the work.

E. O. Lovett.

Lexikon der Kohlenstoff-Verbindungen. Von M. M. Richter. Zweite Auflage der "Tabellen der Kohlenstoff-Verbindungen nach deren empirischer Zusammensetzung geordnet." Hamburg und Leipzig, Verlag von Leopold Voss. 1869.

The work bearing the above title is another product of the indefatigable energy and painstaking care of a German chemist. In 1883 Dr. Richter gave out his 'Tabellen der Kohlenstoff-Verbindungen' arranged in accordance with empirical formulas. While that edition contained 16,000 compounds, and the third edition of Beilstein now reaching completion has some 57,000 compounds described within its spacious pages, this dictionary says something about 67,000.

The work is conveniently divided into the following parts: Introduction, System and Nomenclature; List of about 67,000 compounds and their percentage composition; Register of Proper Names; Table of Numbers for finding the Percentage Composition.

The dictionary is to be issued in about thirty-five numbers, the first eleven of which are at present in hand. Each number contains sixty-five pages and is of the same size, style and print as the *Lieferungen* of Beilstein's 'Organische Chemie,' 3 Auflage.

In the Preface, which, with the Introduction to the system and nomenclature, is given in four languages (German, English, French and Italian), Dr. Richter states that the work was begun ten years ago. Three causes are ascribed for the length of time required to complete the work: viz., changes of nomenclature at the Geneva Convention, the immense number of new facts made known in the time and his own business engagements. Professor Beilstein's desire to exhibit the percentage composition of additional types CHO, CHN, and CHON, thereby adding some 20,000 formulas, has been complied with.

The alphabet of the system shown in the succession of the elements combined with carbon, as determined by the frequency of their occurrence is as follows:

(1) H, O, N; Cl, Br, I, F; S, P.

(2) All the other elements are placed in alphabetical order: A–Z.

The elements follow each other in horizontal and vertical rows according to the number of atoms.

C H O N Cl Br I F S P Al As . . . Zr.
O
N
Cl
Br
I
F
S
P
Al
As
.
.
.
Zr.

The arrangement is really automatic, but there are some explanations given in the Introduction by which an empirical formula may be deduced from the Index of names which accompanies the tables. The lexicon is a collective index to Beilstein for all the compounds therein treated, reference to volume and page being given. Some 8,000 more are also given. These compounds will probably be treated in supplements to Beilstein. Polymeric compounds with fixed molecular weights are registered under their own formulas; $(CHON)_3$, cyanuric acid is found under $C_3H_3O_3N_3$. Reference to purely theoretical papers are omitted, as well as those dealing with analytical, physical, mathematical, crystallographic and medicophysiological data. Papers which describe methods of preparation and properties of the substances and the immediate changes they undergo only are referred to. The immense amount of material has, of course, necessarily been much condensed, authors' names being omitted and abbreviations of journals used. Further, words of frequent occurrence have been abbreviated by using the German abbreviations. This is all explained, however, by a table giving the meanings of the abridgments in the four languages named above.

The author not only recommends that writers in future give the empirical formulas, but also adopt the arrangement of formulas as given in his book. This attempt at uniformity in the writing of formulas has already been inaugurated by the German Chemical Society in the *Berichte* beginning with 1898. An illustrative example may be given; we usually write $C_6H_5NO_2$ (nitro-benzene); by following the order given above this should be $C_6H_5O_2N$. For the sake of classification this is a great convenience and should be insisted upon in the American and English journals, for the immense amount of new material annually added to our already gross number of organic compounds must have systematic arrangement for many obvious reasons. It is by no means desirable, however, that this take the place of the rational formulas, but be given in addition. To economize space, structural formulas are omitted from the volume, but some ten pages are given to the graphic illustration and naming of the ring-systems containing O, S, Se, N, P.

In order to secure a satisfactory nomenclature the 'principle of substitution' was adopted. For example:

"(1) Every compound with fixed constitution is referred to the group-substance from which it is derived, namely, to the hydrocarbon or to the corresponding cyclic system which contains the smallest number of hydrogen atoms, as benzene, naphthalene, pyrrol, etc.

"(2) This group-substance remains intact in naming the derivatives and must always figure as such in the names of the derivatives, no alterations taking place, as pyrazole into pyrazoline, etc.

"(3) Hydrogenized group-substances are named di-, tetra-, etc., hydroderivatives, as dihydropyrazole for pyrazoline.

"(4) Group-substances are named, (*a*) hydrocarbons of aliphatic series in accordance with the resolutions of the Geneva convention; (*b*) for Aromatic hydrocarbons present used terms as benzene, indene, naphthalene, anthracene; (*c*) Ring systems containing O, S, Se, N, P as named in the ten pages adverted.

"(5) As the formation of the derivatives of group-substances may be regarded as taking place by the substitution of hydrogen by other atoms or groups, so are the names derived from the group-substances.

Exception, and wisely, is taken to the Geneva nomenclature convention in indicating the position of the substituent in the open-chain series by letters from the Greek alphabet. In ring-compounds, as is usual, the location is indicated by numbers. The matter is up-to-date.

The entire work is a most valuable contribution to the reference books on Organic Chemistry and no laboratory can well afford to be without a copy. CHAS. BASKERVILLE.

UNIVERSITY OF NORTH CAROLINA,
September 30, 1899.

The Rise and Development of the Liquefaction of Gases. By WILLETT L. HARDIN, PH.D. Macmillans, 1899. 8vo. 250 pp.

Written from a historical point of view and with an ample command of the subject, this book of Dr. Hardin's is really a very satisfactory compilation. It is prepared with evident care and industry, and is finely illustrated. Why a 'popular-science style,' in which it professes to be written, should differ at times from good English, is not plain to the reviewer: but this is the severest criticism that need be made.

The author limits himself to a record of the statements of others, and he is therefore responsible chiefly for the selection and arrangement of his material. Here we might wish that the researches upon the more readily condensable gases, preceding the achievements of Cailletet and Pictet, had been treated more concisely, in order that more room had been found, toward the end of the book, for the discussion of the utilization of liquid air, etc., as at present proposed. The treatment of the latter topic is very scanty, in view of the fact that probably four out of five of the prospective purchasers of the book are interested in the uses of liquefied gases, rather than in the methods of their production. Two chapters, involving thermodynamics, would seem forbidding to the non-technical reader, while they bring no new information to the chemist or physicist. If they could be made the basis of a new chapter, discussing the economic value of gas-liquefaction, for commercial refrigeration and for the intensification of the potential energy of engines, they would serve a most useful purpose.

MORRIS LOEB.

BOOKS RECEIVED.

The Compendious Manual of Qualitative Chemical Analysis. C. W. ELIOT and F. H. STORER. Newly revised by W. B. LINDSAY and F. H. STORER. New York, D. Van Nostrand Company. 1899. Pp. vii + 202. $1.25.

The Evolution of General Ideas. TH. RIBOT. Translated by FRANCES A. WELBY. Chicago, Open Court Publishing Company. 1899. Pp. xi + 231. $1.25.

Wabeno, the Magician. MABEL OSGOOD WRIGHT. New York and London, The Macmillan Company. 1899. Pp. xi + 346. $1.50.

SOCIETIES AND ACADEMIES.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science at St. Louis, held on the evening of October 16th, a paper by Dr. T. J. J. See, on the temperature of the sun and the relative ages of the stars and nebulæ, was presented in abstract by Professor Nipher.

The author reviews the work of Helmholtz on the condensation of a homogeneous sun and finds that the heat developed in gravitational condensation from an infinite volume to its present size would be sufficient to heat an equal mass of water about 27 million degrees. In condensing to a mass whose radius was equal to the radius of Neptune's orbit, only about 1 / 6600 part was produced as has been produced since. Nearly all of the heat has been developed since the primitive nebula has reached the dimensions of the solar system. The heat developed before the nebula came within the orbit of Mercury, is only about 1 / 85 part of the total heat produced up to the present time. If the sun should contract 1 / 10000 part of its present radius, 69,700 M., assuming it to be homogeneous, the heat would raise the temperature of an equal mass of water 2,725 degrees. The effect of the various planets is considered, and is shown to be insignificant. An annual shrinkage of 35 meters a year would account for the present heat and would effect the radius less than 1 / 10″ in 1,000 years. The fact that ancient and modern eclipses are sensibly of the same duration, in connection with the substantial constancy of the moon's mean distance, shows that no considerable alteration of the sun's diameter has occurred in historical time. The essential constancy of solar radiation during the last 2,000 years is well established by the agreement of plant distribution now with that described by Pliny and Theophrastus.

Dr. See then takes up the case of a hetero-

geneous sphere made up of layers of uniform density, but increasing in density towards the center.

The radiation as at present determined is assumed to apply to all time past and present, and the density is assumed to vary from center to circumference, in accordance with Lane's deductions in 1870, the value of K_e, the ratio of the two specific heats being 1.4.

Lane found the density at the center to be 23 times that of water, and by a different process, Kelvin has found it to be 32 times that of water.

Assuming a surface temperature of 8,000 degrees, as found experimentally by Wilson and Gray, the temperature at the center comes out 256,000 degrees C.

The potential of the heterogeneous sun thus assumed is then found by mechanical integration, by dividing the radius into 40 parts, the density of each shell being constant.

The energy developed by the falling together of the parts of this heterogeneous sun is greater than for the homogeneous sun of Helmholtz in the ratio of 176 to 100. As in the past history of the Helmholtz sun, the radiation would have dissipated this heat at the present rate of radiation in 18 million years, it follows that if the Helmholtz sun should pass into the heterogeneous sun, discussed by See, by inward gravitation of particles, the past history is increased by about 14 million years. This augmentation of its past is at the expense of its future duration.

The author gives reasons for thinking that condensation cannot go on unchecked by molecular forces after the radius has shortened to much over one-half its present length, and assigns 36 million years as a fair value for the total life of the sun from the time its radius was that of Neptune's orbit to the time when its radiation will become insignificant. Of this total period 32 million years, or 8 / 9 of the whole, have already elapsed, leaving four million years for a fair estimate of its future duration, with the conditions assumed.

There is reason to believe that under the immense temperatures existing in the sun, the gaseous mass may be so dissociated that all gases behave like monatomic gases. This would increase the ratio of specific heat at constant pressure to that of constant volume from 1.4 to 1.66. This changes the law of density and temperature along the radius. The density at the center becomes much less and the potential of the whole mass upon itself is correspondingly less exhausted. It increases the probable future life of the sun from four to 13 millions of years, and diminishes its past history from 32 to 23 million years. The author concludes that life as it now exists on the earth cannot be maintained longer than three million years, and after five or ten million years, the planet will have become a rigid and lifeless mass.

Dr. H. von Schrenk presented some notes on *Arceuthobium pusillum* which was found in Maine, during the past summer, growing on the white spruce along the sea-coast. The trees which are attacked form large witches' brooms, the branches of which are much longer than the normal branches. The manner in which the seeds are distributed was briefly described, and seeds were exhibited adhering to branches of the white spruce.

WILLIAM TRELEASE,
Recording Secretary.

WASHINGTON CHEMICAL SOCIETY.

THE regular meeting was held May 11, 1899.

The first paper of the evening was read by Professor F. W. Clarke and was entitled: 'Experiments on the Constitution of Certain Silicates,' by F. W. Clarke and George Steiger.

The paper cited some results obtained by Clarke and Schneider in 1889–92. The present work led to the following conclusions:

1. That pectolite is a metasilicate.

2. That the formula for pyrophyllite is possibly that of a basic di-metasilicate.

3. That calamine is probably a basic metasilicate which is in accord with the accepted formula.

With analcite a very interesting ammonia compound was formed, by heating with ammonium chloride. Other experiments agreed closely with those made by Friedel and it was concluded that this mineral is a mixture of ortho- and tri-silicates.

The last paper of the evening was ready by Dr. H. N. Stokes and was entitled: 'Indexing Organic Compounds.'

Mr. Chesnut exhibited utensils used by the Indian women in the preparation of acorn meal.

WILLIAM H. KRUG, *Secretary*.

ASTRONOMICAL NOTES.

CLOCK RATES AND BAROMETRIC PRESSURE.

ENSIGN EVERETT HAYDEN, U. S. Navy, publishes in the Publications of the Astronomical Society of the Pacific, No. 68, an interesting investigation of the effect of variations in barometric pressure upon the rates of clocks and chronometers. This study was made at the Mare Island Observatory, where chronometers are rated for the U. S. Navy, and where the time observations are regularly made, which are supplied by the Western Union Telegraph Company to that part of the country west of Ogden, Utah. The paper gives in detail the results for the Mean Time Clock of the observatory and for three Negus chronometers. The method is empirical, depending upon the rates actually observed under varying pressure and temperature, and the numerical results are obtained graphically. From tests of the Mean Time Clock extending through two hundred days, it is believed that had the rate-curves been used without any time observations the errors of the noon signal would at no time have exceeded six-tenths of a second, and seldom have exceeded one-tenth of a second, and at the end of the period would have been correct within a few hundredths of a second. The barometric and temperature curves of the sidereal and mean time clocks are now used in the current work of the observatory, and the author is of the opinion that a first rate pendulum clock is a much better instrument than usually supposed, and actually comparable in uniformity with the axial rotation of the earth, if account is taken of these variations. The experiments on chronometers lead the author to believe that the use of a barometric curve in actual practice at sea is worthy of trial, and the navigator of one of our naval vessels now in the Pacific will report upon his experience with the three chronometers whose rates are discussed in the paper.

STELLAR PARALLAX BY PHOTOGRAPHY.

A CONTRIBUTION to this subject is made by Östen Bergstrand of the observatory at Upsala. The author discusses the theory of the reduction of measures on the photographic plates and the instrumental errors of the Repsold apparatus employed. The parallax of Σ 1516 *A* is found to be $0.''080 \pm 0.''011$ and of *A – Oe.* 11677, which has a proper motion of nearly 3″, to be $0.''192 \pm 0.''013$. These determinations were made on account of the discrepancies in the results of other observers. The paper is in Swedish but an abstract in French is supplied.

JUPITER'S FIFTH SATELLITE.

PROFESSOR BARNARD has added to our knowledge of the period of this satellite the results of his observations in the last two oppositions of Jupiter made with the 40-inch equatorial of of the Yerkes Observatory. Combining these with the earlier observations at the Lick Observatory, the period is 11 h. 57 min. 22.647 sec. and is not in error exceeding 0.01 sec. The discordancies in the separate determinations are very small and the measures show the great accuracy attainable in micrometric observations with these large refractors upon difficult objects.

WINSLOW UPTON.

PROVIDENCE, R. I., Oct. 14, 1899.

CURRENT NOTES ON METEOROLOGY.

KITE AND BALLOON METEOROLOGY IN FRANCE.

Two communications have been made to the French Academy of Sciences during the past summer by Teisserenc de Bort on the kite and balloon work carried on at the Observatory of Trappes. Altitudes of 3,940, 3,590 and 3,300 meters were reached on June 14th, June 15th, and July 3d, respectively. The results obtained by means of the kite meteorographs during more than 100 ascents show that in anti-cyclones the rate of decrease of temperature aloft becomes slower at a distance of a few hundred meters above the ground, and inversions of temperature are often observed. In cyclonic areas the decrease of temperature is more rapid. In fine weather, with high pressure, the wind velocity generally decreases with increasing distance from the ground up to an altitude between 1,500 and 3,000 meters. On the other hand, on cloudy days, with low pressure, the velocity

increases with altitude, especially near the lower cloud stratum. (Paper read, July 10th.)

Some of the results obtained during more than 100 ascents of *ballons-sondes*, 7 of which ascents were higher than 14,000 meters, 24 higher than 13,000 meters, and 53 of which reached 9,000 meters, were discussed by de Bort in a paper read before the Academy on August 21st, last. The most important conclusions reached are as follows: I. The temperature at different altitudes shows notable variations during the course of the year, which are much greater than was supposed as the result of the older observations made in balloons. II. It appears that there is a fairly well-marked tendency to an annual variation of temperature as high up as 10,000 meters, the maximum being reached towards the end of summer, and the minimum at the end of the winter. This phenomenon is much complicated by the marked variations from day to day, which are related to the conditions of atmospheric pressure.

CENTIGRADE *versus* FAHRENHEIT SCALE.

THE discussion as to the relative merits of Centigrade and Fahrenheit scales has lately come up again in connection with the use of these scales in meteorological work. In *Nature* for August 17th, Buchanan points out that the zero on the Centigrade scale occurs at such a place as to make nearly half of the readings come below zero. Hence the scale must be read upward half the time and downward half the time, which is awkward. Furthermore, the averaging of the results is extremely troublesome, and mistakes are easily made. Clayton (*Nature*, Sept. 17th), agrees with the opinion expressed by Buchanan, and makes the novel and ingenious suggestion that if the Centigrade thermometer is ever adopted for meteorological purposes by the English-speaking nations, the freezing point of water should be marked 273° on the scale and the boiling point 373°. By this method meteorologists would have at once the temperatures concerned in the change of volume of gases, and embodied in many formulæ, and the difficulty of the inverted scale, above referred to, would be eliminated.

R. DEC. WARD.

HARVARD UNIVERSITY.

NOTES ON INORGANIC CHEMISTRY.

A PAPER on Solid Hydrogen was read by Professor Dewar at the Dover meeting of the British Association and is reprinted in the *Chemical News*. It is only since the fall of 1898 when it has been possible to obtain liquid hydrogen in quantities of one or two hundred cubic centimeters, that attempts could be made to solidify it. The principle used was that of a vacuum tube containing liquid hydrogen immersed in a bath of liquid hydrogen contained in an outer vacuum tube connected with an air pump. When the pressure in the outer tube is reduced below 60 mm., the hydrogen suddenly solidifies into a white froth-like mass like frozen foam. In the inner tube the upper part of the solid hydrogen is frothy, but below it is a clear solid resembling ice. The solid melts at a pressure of 55 mm., or under a pressure of 35 mm. at 16° absolute (—257° C.). The boiling point of liquid hydrogen at 760 mm. pressure is 21° absolute (—252° C.). The foamy structure of the solid hydrogen is doubtless due to the fact that rapid ebullition is substantially taking place throughout the entire liquid, owing to its extreme lightness, for the specific gravity of liquid hydrogen is only 0.07 at its boiling point, and its maximum density not over 0.086. The lowest temperature now obtainable is from 14° to 15° absolute (—259° to —258° C.), reached by the evaporation of solid hydrogen in a vacuum.

A NEW method of separating the active constituents of racemic compounds is described by Marckwald and McKenzie in the last *Berichte* of the German Chemical Society. It is based upon the fact that while isomeric acids of the fatty series have nearly the same affinity, and the same limit of ester formation, the speed of the latter depends very markedly upon the structure of the acid molecule. In the described experiment racemic mandelic acid and menthol were heated together for an hour—menthyl mandelic ester was formed and that portion of the mandelic acid which was unacted upon was recovered and found to be lævo-rotary; the dextro-rotary acid was thus changed to the ester first. While perhaps of no practical application, this method is of theoretical interest, as it adds a purely chemical method of

splitting racemic compounds, to the three already known, the mechanical, the bio-chemical and the physical.

J. L. H.

LIMITATIONS OF THERMODYNAMICS.

An important paper has recently been issued from the press of Dunod as a reprint from the *Revue de Mécanique*, current volume, in which M. Georges Duchesne presents the results of a very extensive experimental study of the thermal and thermodynamic processes in operation in the steam engine and especially during the period of emission, which has been the most difficult of investigation and the most obscure of all the elements of the vapor-engine cycle.*

With a vapor engine in steady operation the observation of the amount of liquid passing through the system in the unit of time gives the measure of the quantity taken into the working cylinder at each stroke of its piston, and this, with the determination of 'quality' by the 'calorimeter,' and automatic registration of volumes and pressures, by the 'indicator' of Watt, permits the exact apportionment of energies and the physical condition of the fluid to be determined from the instant of closure of the induction-valve to its opening at the commencement of exhaust. The delineation of the 'saturation-curve' on the indicator-diagram, for the quantity of fluid known to have entered the cylinder, gives the measure of contemporaneous volumes of the corresponding quantity of 'dry and saturated' vapor which serves as the unit of the scale measurements of the relative volumes, and weights of liquid and vapor in the mixture constituting the working fluid, or the extent of superheating, if at any point superheated. From the instant of commencement of emission, however, no measure is obtainable of these quantities, and the problem becomes incapable of solution by ordinary observation.

Donkin has sought the solution of this particular question of the state of the vapor in the period of emission and that of compression by the use of his 'revealer,' by means of which the fluid is sampled and tested as to quality, and Professor Carpenter, in the laboratories of Sibley College, has sought the same end by the use of the now familiar 'steam-calorimeter,' taking off samples of the steam automatically at certain points in the portion of the cycle to be investigated. Donkin concluded that the vapor in the exhaust period was wet; Hirn, Carpenter and others, including Dwelshauvers-Dery, have found it dry. M. Duchesne revises the work of Donkin, particularly, and concludes that, contrary to the deduction of the investigator himself, the research indicates that the vapor is dry and saturated during the period of emission. He decides that the results of those experiments furnish 'proof of the complete dryness of the surface at the end of emission.' If dry at this point, they will presumably continue dry up to the beginning of the period of compression, and, then, mechanical compressions alone affecting the fluid, superheating should occur. This was the conclusion of the writer long before the apparatus and method of recent research was ready to give its testimony in the case,* as respects economically operated engines; but the contrary as regards uneconomical engines, in which the working fluid, after entering the cylinder, is very wet, and Willans based upon the same conviction the details of design in his engine insuring that the moisture deposited upon the cylinder-walls should be swept off as thoroughly as possible by the current of the working fluid. M. Duchesne finds confirmation of these anticipations in the work of Hirn, of Delafond and of Dwelshauvers-Dery; the latter affording him very conclusive evidence, which he reviews at length.

The conclusions reached are the following, in substance:

(1) When, in the engine-cylinder, the vapor is saturated and the walls humid, the vapor and the water on the surface of the metal in immediate contact with the liquid assume almost instantaneously the same temperature.

(2) If the surface is dry, it may take a temperature superior to that of the fluid.

* L'état de la Vapeur a la Fin de l'Émission; par Georges Duchesne, Ingénieur, ancien Assistant du Professeur V. Dwelshauvers-Déry; Paris, Vve. Ch. Dunod, 1899. Royal 8vo., pp. 15.

* Manual of the Steam-Engine, Vol. I., § 53, pp. 355–627, especially p. 631. Trans. A. S. M. E., 1890, No. CCCLXII.; 1894, No. DLXVI.; 1894, 1896, pp. 843, etc.

It is to be remembered that the nearer the fluid to the state of saturation, the more readily does it surrender heat.

In the indicator-diagram it is often observed that there exists a point of inflexion at the summit of the compression-curve. This has been, by earlier authorities, generally ascribed to leakage past the piston on attaining a certain limiting pressure at which the piston-rings yield. Later observers have suspected and the writer has long believed that this peculiar inflexion may mark a point at which the surrender of heat of compression to the metal of the cylinder-wall occurs so rapidly, as a consequence of the increasing temperature-head, as to cause more rapid condensation than can be counteracted in its effect upon pressure by the constantly diminishing rate of compression. This phenomenon, in such case, is an indication, if not a measure, of the heat-exchange thus taking place. M. Duchesne finds confirmation in his own experiments of this later idea, and of the propositions which he has advanced, as well as of the accuracy of the work of M. Dwelshauvers-Dery.

R. H. Thurston.

Cornell University.

SCIENTIFIC NOTES AND NEWS.

The National Academy of Sciences will hold its annual fall meeting at Columbia University, New York, from November 14th to 17th.

Professor Dean C. Worcester, of the University of Michigan, has returned to the United States, to report to the President as one of the members of the Philippine Commission.

Professor George T. Ladd, of Yale University, who is at present in Japan, has received from the Japanese Emperor, the third-class decoration of the Order of the Rising Sun.

Dr. Eugene A. Darling has been appointed bacteriologist of the Cambridge Board of Health, to succeed Dr. George B. Henshaw.

Mr. W. H. Twelvetrees, F.G.S., has recently been appointed to the position of geologist to the Government of Tasmania.

Dr. Alfred Jentzsch, docent at Königsberg, has been appointed geologist of the Government Survey in Berlin.

Dr. Otto Lubarsch, associate professor at Rostock, has been made director of the pathological and anatomical division of the newly established State Institute of Hygiene at Posen.

Mr. J. E. Duerdin, curator of the Kingston Museum, Jamaica, is this year studying at the Johns Hopkins University.

Mr. W. H. M. Christie, C.B., the Astronomer Royal has been elected one of the Wardens of the Clockmakers' Company.

Dr. Louis L. Seaman offers, through the Military Service Institution of the United States, a prize of $100 for the best essay on 'The Ideal Ration for an Army in the Tropics.' Papers should be received before March 1, 1900.

Mr. Hamilton Y. Castner, died at Saranac Lake, N. Y., on October 10th, aged 41 years. Mr. Castner made important advances in industrial chemistry, especially in the manufacture of aluminium and in the electrolytic processes of manufacturing caustic soda and chlorine from cloride of sodium.

The death is announced at Obersdorf of Dr. Ernst Rosenberger, known for his writings on the history of physics.

Dr. Karl Russ, the ornithologist, died at Berlin on September 29th, aged 66 years.

It has been proposed to place a bust and an enlarged photograph of the late Dr. Friedel in the hall of the Sorbonne. The estimated cost of the bust, which will be the work of M. Uitain, is 3,000 francs. An appeal for subscriptions has been issued. These should be sent to M. Chason, at the Laboratory of Organic Chemistry, Faculty of Science, the Sorbonne.

At the ceremonies attending the unveiling of the monument of Johannes Müller at his birthplace, Coblentz, on October 2d, Professor Virchow was the principal speaker. The British *Medical Journal* states that in the course of his address Professor Virchow referred to the difficulty that had been found in choosing an appropriate inscription. The simple one chosen by the sculptor: 'To the great anatomist and physiologist,' would perhaps hardly satisfy all concerned. Strictly speaking, Johannes Müller was a biologist, a naturalist whose aim

was the study of life itself in its universality. He was the first to use the microscope in researches on living beings; he was the first to disclose to us the fauna of the seas. His example inspired the deep-sea researches of our own day, of which the German scientific station in Naples formed a center. Professor Koester, Rector of Bonn University, speaking as the representative of the Monument Committee, handed over its charge to the mayor and municipality of Coblentz. Professor Waldeyer, Rector of the Berlin University, made the closing speech as the delegate both of the Berlin University, where Müller's chief teaching years were spent, and of the Prussian Academy of Sciences. In these two institutions, said Waldeyer, Johannes Müller had raised a monument to himself that no time could destroy.

THE Seventeenth Congress of the American Ornithologists' Union will convene in Philadelphia, at the Academy of Natural Sciences, 19th and Race Sts. (Logan Square), on Monday, November 13th, at 8 o'clock p. m. The evening session will be for the election of officers and members and the transaction of other routine business. The meetings open to the public, and devoted to the reading and discussion of scientific papers, will be held in the Lecture Hall of the Academy, beginning Tuesday, November 14th at 11 a. m., and continuing for three days. Information regarding the Congress can be had by addressing the Secretary, Mr. John H. Sage, Portland, Conn.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler, at Lick Observatory, stating that the following elements and ephemeris of Comet *e*, 1899, were computed by Perrine from observations on October 1, 7, 16:

Time of passing perihelion	$=T=$	Sept. 15.04 G. M. T.
Perihelion minus node	$=\omega=$	10° 52′
Longitude of node	$=N=$	272° 13′
Declination	$=i=$	76° 55′
Perihelion distance	$=q=$	1.7854

EPHEMERIS.

1899. Oct. 24,	R.A. $17^h\ 5^m\ 8^s$.	Dec. +2° 17.′	Light 0.72
" " 28,	" 17 11 12.	" +3 21.	
" Nov. 1,	" 17 17 24.	" +4 25.	
" " 5,	" 17 23 36.	" +5 29.	" 0.63

THE American Museum of Natural History, New York, will hereafter be opened free to visitors on Wednesdays, Thursdays, Fridays and Saturdays, on Sunday afternoons and on Tuesday and Saturday evenings. The free lectures given under the auspices of the Board of Education are on Tuesday evenings and the lectures by Professor A. S. Bickmore to teachers in the public schools are on Saturday mornings.

THE London correspondent of the New York *Evening Post* states that two expeditions will soon take the field in South America. Professor Zittel, of Munich, is arranging to send a scientific expedition to Patagonia, and it is very probable that a similar undertaking will be organized in London on very comprehensive lines, the Argentine Government having promised to render aid and grant all facilities to a British expedition under responsible or official control.

Nature, quoting from the *Civil and Military Gazette*, Lahore, states that the Indian Government has under its consideration a somewhat comprehensive scheme for the establishment of research laboratories in various parts of India, and the appointment of health officers to take charge of them. The present laboratory at Muktesar will, it is understood, be further developed and the staff increased, the establishment becoming the central research laboratory for India, and health officers will be appointed to the charge of laboratories at Calcutta, Madras, Bombay, Agra and Lahore, the new department of bacteriology being ordinarily manned by officers of the Indian Medical Service.

THERE has been an active and somewhat acrimonious discussion in the English journals in regard to the extent to which physicians receive commissions. It is said that in the United States physicians do not receive commissions from pharmacists to any considerable extent, but suit has just been brought by a San Francisco physician for $300, which he claimed as a commission on prescriptions sent to a druggist. Complaint is also made that some of the younger surgeons in New York ophthalmic hospitals receive commissions from opticians.

A MEETING of the Society of Engineers was held at the Royal United Service Institution,

Whitehall, on October 2d, Mr. John C. Fell (President), in the chair. According to the account in the London *Times*, a paper was read by Mr. J. Bridges Lee on 'Photographic Surveying.' The author set out in detail the special advantages of the photographic method. Among these advantages are: (1) A more complete and accurate record than can be obtained by any other means; (2) saving of time in the field; (3) ability to take full advantage of short clear interludes in unsettled weather; (4) special advantages for military purposes in an enemy's country; (5) utility for travelers rapidly traversing a country; (6) usefulness for detecting geological and physiographical changes; (7) economy in operation. The author then passed in review the various kinds of photo-topographic apparatus which had beeen designed and constructed, pointing out the distinctive features of most of the best known instruments. All the best photographic survey work everywhere had been done with plane projection instruments. The author described the improvements made by him, designed to facilitate the subsequent interpretation of the photographs. These improvements consist of certain mechanical appliances inside the camera for securing an automatic record on the face of every picture taken of the horizon and principal vertical lines, of the compass bearing of the optic axis or principal plane, of a scale of horizontal angles applicable to all points visible in the picture, and of memoranda of useful information relating to the particular picture.

REUTER'S AGENCY reports that Dr. Carl Peters, the explorer, left Portuguese territory at the beginning of August, and crossed into Mashonaland, taking with him two of his prospectors, Messrs. Blocker and Gramann. The rest of his expedition he left in the neighborhood of the ancient ruins re-discovered by him near the Zambesi. He expresses his intention of establishing a permanent station on the Inyanga Highlands, and from that point of exploring the whole of Mashonaland from north to south. Besides gold, Dr. Peters claims to have discovered mica, saltpeter, and diamonds in a district practically uninhabited at an altitude of 8,000 feet, and, he believes, easily capable of cultivation. As the rainy season is now setting in Dr. Peters will, after exploring some districts on the Pungwe River, proceed to Beira *en route* for England.

AT a special meeting of the American Forestry Association at Columbus, in connection with the meeting of the American Association, resolutions were adopted recommending:

1. The creation of an international commission, through M. Meline, of Paris, to arrange for a Congress of Forestry at the Paris Exposition of 1900.

2. The purchase and reservation, by the State of Ohio, of tracts of timber land at the headwaters of the principal rivers of the State in order to prevent the increasing loss of life and property by flood, and for the better preservation of a water supply in time of drought.

3. The establishment of colleges and schools of forestry in the various States, with as much assistance as possible, in encouragement of the work, from the Department of Agriculture.

4. Commending the policy adopted by the State of Pennsylvania in the appointment of an expert forester to organize and conduct the forest interests of the State, and to educate its citizens in practical forestry.

5. Urging the suitable presentation of the subject of forestry at the meetings of teachers' associations, farmers' institutes, and other similar gatherings, "to the end that the people may be taught to give earnest attention to this much-neglected, but vitally important interest."

THE Vienna correspondent of the London *Times* writes that the trials of the system of rapid telegraphy invented by two Hungarians, MM. Pollak and Virag, which took place between Budapest and Berlin at midnight on September 29th, are represented to have practically justified the claims made on behalf of the new process. The experiments were conducted at both ends under the personal direction of the inventors in the presence of experts, including representatives of the Hungarian and French governments and one of the American cable companies. These are alleged to have given the extraordinary result of a transmission of no fewer than 220 words in ten seconds without prejudicing the clearness of the message. A perforated roll of paper, similar to that at present in use, is employed for the dispatch of the message, which is made visible and fixed photographically at the receiving station. Instead

of the dashes and dots of the Morse alphabet, there are rising and falling strokes starting from a horizontal line. The receiver consists of a telephone fitted with a small concave mirror, upon which are reflected, in the form of streaks of light, the impulses marked on the membrane. By an ingenious arrangement, recalling in some respects that of the cinematograph, the streaks of light reflected upon the mirror are reproduced upon a roll of sensitized paper, thus giving a narrow oblong picture, which in the present stage of the invention is developed and fixed like any ordinary photograph.

WE learn from the *Electrical World* that a singular decision has been made in the Senate of the Supreme Court of the Empire of Germany. Last December three mechanics attached a wire to a cable laid in the house where they lodged, and stole electricity enough to light their rooms. The Provincial Court sentenced them each to one day's imprisonment. The decision was based on the principle that electricity possessed the essential properties of a movable object. It has gone from court to court, and now the Senate holds that the judgment of the Provincial Court must be quashed on the grounds that the law provides only against the theft of movable bodies, and the court holds that those properties are wanting in electricity which would be necessary to constitute it a movable object in the sense of the law. The sentence states that electricity must be regarded as one of the energies of nature, like sound, light and elasticity. It was also decided that damage to property cannot be pleaded, for that requires that the substance of the object must be affected. Again, it was held that property has been withdrawn from the wire, but the Senate denies this, for electricity is not one of the properties of copper wire, so it is unanimously concluded that the law as it is in Germany tapping an electric current is not theft.

UNIVERSITY AND EDUCATIONAL NEWS.

DR. ARTHUR TWINING HADLEY was duly inaugurated as president of Yale University on October 18th, in the presence of a distinguished audience, representing the chief universities of the United States. Dr. Hadley took the oath of office and made the inaugural address. Professor George P. Fisher, of the Divinity School, made the congratulatory address on behalf of the faculty.

COLONEL RUTHERFORD B. TROWBRIDGE has given $10,000 to the Art School of Yale University.

FUNDS are being collected for a graduate fellowship at Mt. Holyoke College in memory of Elizabeth Miller Bardwell, formerly director of the astronomical observatory.

THE committee appointed by the National Educational Association to consider the plans for a National University at Washington will meet in that city on November 2d. The committee consists of President Wm. R. Harper, Chairman, President Alderman of the University of North Carolina, President Angell of the University of Michigan, Professor Butler of Columbia University, Dr. Canfield of Columbia University, Mr. J. L. M. Curry, Washington Agent of the Peabody and Slater Funds; Superintendent Dougherty of Peoria, President Draper of the University of Illinois, President Eliot of Harvard University, Professor James of the University of Chicago, Superintendent Maxwell of New York, Professor Moses of the University of California, President Schurman of Cornell University, President Wilson of Washington and Lee University, and Superintendent Soldan of St. Louis.

COMMERCIAL education was the subject for discussion at the sessions of the International Commercial Congress on October 28th. President Low, of Columbia University, presided. Addresses were also made by President Eliot, of Harvard University, President Schurman, of Cornell University and President Harrison, of the University of Pennsylvania.

A SPECIAL committee has presented a report to the general meeting of the Convocation of the University of London. The following are among its recommendations: (1) There should be only one faculty of science with adequate representation on the Senate and the Academic Council. (2) Engineering should be a distinct branch of the one faculty of science and not a

separate faculty, but degrees should be given in engineering bearing a distinctive name. (3) If it should be thought expedient to constitute a distinct branch of the faculty of science for any other scientific profession, there is not, in the opinion of my committee, any present occasion for giving a distinctive name to degrees to be taken in that branch. (4) If, contrary to the opinion of the committee, the subjects of the faculty of science should be divided by the commissioners, for electoral purposes, into several faculties, the committee hope they may be afforded an opportunity of giving further consideration to the principles upon which such division should be effected, especially in connection with the effect which the division would have upon the University examinations and degrees. (5) With regard to the position to be occupied by the art or profession of teaching, the committee think that this subject should find its place as a branch of the faculty of arts. (6) With regard to the proposal which has been made in more quarters than one to constitute a new and separate faculty for economic, commercial and social subjects, including, perhaps, administrative law, the majority of the committee think that this proposal is justified by the wide range and high importance of the subjects concerned, and the great and growing interest which they now attract. (7) With regard to the proportional representation of the faculties on the Senate and the Academic Council, the committee think that if the distribution of the faculties should accord with their suggestions the 16 representatives should be allocated as follows: To the faculty of science 5, arts 4, medicine 3, law 1, theology 1, music 1, economics 1—total 16.

According to *Nature* the work of the South African School of Mines, Kimberley, is now carried on in suitable premises, which were completed in the beginning of this year at a cost of about 9000*l.* Of this sum 2000*l.* was given by the Government of Cape Colony, 2000*l.* by the De Beers Company, and 5000*l.* was borrowed. The school has been established to carry out part of a scheme for the training of mining engineers in South Africa. The courses of instruction are intended to prepare students for a diploma of mining engineer, or for the degrees of B.Sc. or M.Sc. in mining engineering. Theoretical and practical instruction is given, under the direction of the principal, Mr. James G. Lawn, in mining, mechanical and electrical engineering, metallurgy, assaying, surveying and other subjects. Practical work is carried on in the mines and workshops of the De Beers Company, and also in various mines at Johannesburg. The time spent at Johannesburg is devoted to a special study of the cyanide process in all its developments, of the electrical machines and appliances at the mine where the student is working, of the methods of assaying and surveying, and of the economics of mining on the Rand. A thorough training for mining engineers is thus provided in connection with the school, the course of work described in the prospectus being of a very satisfactory character.

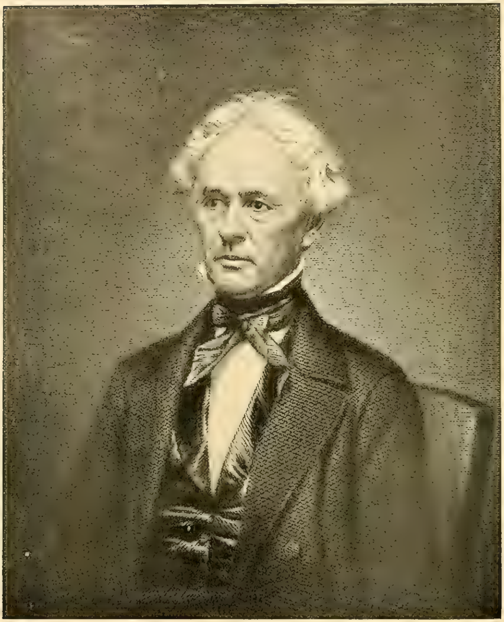
Teachers in Philadelphia public schools will hereafter be allowed to take their classes for a half day once or twice a year to the Zoological Gardens and Fairmount Park, the visit being regarded as part of the regular class duties. The managers of the Zoological Gardens have supplied a large number of tickets for this purpose.

Andrew Gray, M.A., LL.D., F.R.S., professor of physics in the University of North Wales since 1884, has been appointed professor of natural philosophy in Glasgow University, to succeed Lord Kelvin. Professor Gray graduated from the University of Glasgow and was afterwards assistant to Lord Kelvin.

J. S. E. Townsend has been elected a fellow of Trinity College, Cambridge. He submitted papers on 'The Magnetization of Liquids' and 'Electricity in Gases and the Formation of Clouds in Charged Gases.'

Dr. W. E. Dixon, late Salter's Research Fellow in pharmacology at Cambridge University, has been appointed assistant to the Downing professor of medicine, and Dr. L. Humphry has been made assessor to the Regius professor of physics.

Dr. W. König of Frankfurt has been called to an associate professorship in the University of Greifswald. Professor G. Sclavunos has been made professor of anatomy and director of the Anatomical Institute at Athens.



WILLIAM C. REDFIELD.

SCIENCE

FRIDAY, NOVEMBER 3, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.**

I.

FOR a second time in its history the Section on Social and Economic Science in the American Association for the Advancement of Science has chosen for its presiding officer one whose early training was that of a chemist. It had been my hope to present before you an address that should treat of certain phases of the development of industrial chemistry in the United States. The suggestion, however, made at the midwinter meeting in New York by Professor Putnam, that I prepare an account of the early history of the Association, appealed to me so strongly that I was very glad to yield to the wishes of the Council, who promptly accepted the recommendation of our distinguished President, and, therefore, I have the honor of addressing you on The Early Presidents of the American Association.

HISTORY.

The American Association for the Advancement of Science came into formal existence in the city of Philadelphia, on September 20, 1848. The prevalent fondness for genealogical research affords us an ex-

* Address of the Vice-President and Chairman of Section H—Anthropology—of the American Association for the Advancement of Science, Columbus, August 21, 1899.

cellent excuse for a brief discussion of its ancestry.*

For a century preceding the existence of our Association, Philadelphia had held foremost rank as a scientific center. It was in that city as early as 1743 that Benjamin Franklin, America's first great scientist, had made futile effort to form a society "of *virtuosi* or ingenious men residing in the different colonies to be called the American Philosophical Society." † That society, however, as is well known, did organize in 1769, and still survives, the oldest of scientific societies in the United States. An interesting evidence of the fact that Philadelphia was a Mecca to scientific men is the statement that Priestley, on his arrival in New York in June, 1794, declined to give a course of lectures in that city, and proceeded at once to Philadelphia, where he received a complimentary address from the American Philosophical Society.‡

In the early dawn of the new century came that wonderful development of science in New Haven, brought about by the influence of the elder Silliman, who, by the way, first studied chemistry in Philadelphia under James Woodhouse. In the year 1819, in the philosophical room of Yale College, there was organized the American Geological Society, of which, according to G. Brown Goode, our Association 'is essentially a revival and continuation.'§ "Its members," says the same authority, "following European usage, appended to their names the symbols 'M.A.G.S.,' and among these were many distinguished men, for at that time almost every one who studied any other branch of science, cultivated geology also." * If we accept the American Geological Society as our ancestor, it gives the American Association rank as the fifth oldest scientific body in the United States.

As knowledge grew and education advanced, the desire for frequent intercourse among men of science increased more and more, and in the rooms of the Franklin Institute in Philadelphia, on April 2, 1840, there was organized the Association of American Geologists. This society, which two years later became the Association of American Geologists and Naturalists, is officially recognized as our progenitor, and the record of the eight meetings is given in the preliminary pages of our annual volume of proceedings. Of the founders of that Association the venerable Martin H. Boyé still survives,† and in New York City, Oliver P. Hubbard, who served as its secretary in 1844, remains to us a living witness of the mighty events that have occurred in the golden era of science.

It will not be out of place, I am sure, to mention the influence of the National Institution for the promotion of science on the formation of our Association. It was that Institution, which in April, 1844, brought together in Washington City the first National Congress of scientific men—the first cosmopolitan assemblage of the kind which in any respect foreshadowed the great congresses of the American Association in later years.‡

* In *The Chautauquan*, Vol. XIII., p. 727, September, 1891, there is a historical sketch of The American Association for the Advancement of Science, by the present author, which may be of some interest to the student of the history of American science.

† The Origin of the National Scientific and Educational Institutions of the United States, by G. Brown Goode. Annual Report of the American Historical Association for the year 1889. Washington, 1890, p. 54.

‡ The Development of Science in New York City, by Marcus Benjamin. Memorial History of the City of New York. New York, Vol. IV., p. 415.

§ Goode, op. cit., p. 112.

* Goode, op. cit., p. 112.

† The *Scientific American*, Vol. LXXIV., p. 430, for December 12, 1896, under the title of 'A Pioneer of Science,' gives an interesting account of Martin H. Boyé with a portrait.

‡ The First National Scientific Congress (Washington, April, 1844) and its connection with the organization of the American Association. Report U. S. National Museum, 1897 (in press).

This Institution, so successful that it was perhaps the most powerful "agency in setting in operation the influences which led to the establishment of the Smithsonian Institution, the National Observatory, the National Museum and the Department of Agriculture, and in later years, of the National Academy of Sciences," * yet so unsuccessful that "the Smithsonian fund, which it aspired to control, was placed under other authority; the collections and manuscripts of the United States Exploring Expeditions were removed from its custody; the magnificent collection in natural history, ethnology and geology, which had accumulated as a result of its wonderful activity and enthusiasm, soon became a burden and a source of danger," † was abandoned by its founders and supporters, and finally in 1861 went out of existence by the termination of its charter. Its remarkable history has been told by G. Brown Goode in a paper in which he showed its connection with the organization of our Association. In closing he said of the American Association:

The new society was born, and it is significant that the name first adopted was as nearly as possible a combination of the names of the two societies. The one contributed the first half of the name, 'The American Association,' the other the second half—'for the Promotion of Science.' The word advancement in place of promotion was substituted afterwards. ‡

The history of the Association is a task that must be left for other, more competent members to present to you. To me has been assigned the duty of briefly reviewing the career of that brilliant galaxy of men who have been chosen by you to preside over the meetings of the American Association for the Advancement of Science.

* Idem.

† Idem.

‡ Goode, First National Scientific Congress.

REDFIELD.

William C Redfield "who was the first to suggest the idea of the American Association in its present comprehensive plan, and the first to preside over its deliberations,"* was born at Middletown, Conn., on March 26, 1789. As a boy he received only the simplest rudiments of education, and at the age of fourteen was apprenticed to a saddler. At that time he evinced a remarkable fondness for books, and, we are told, that "he was denied even a lamp for reading by night much of the time during his apprenticeship, and could command no better light than that of a common wood fire in the chimney corner."† Through the interest of Dr. William Tully, a learned and distinguished physician of Cromwell, Conn., he was accorded the privilege of that good doctor's library, and chose Sir Humphrey Davy's Elements of Chemistry with which to occupy his leisure moments. In returning the book he surprised its owner by showing a thorough acquaintance with its contents, and in particular with the doctrine of chemical equivalents, which, he said, he had then met with for the first time.

On the completion of his apprenticeship, early in 1810, he made a long journey on foot to Ohio, passing through New York and northern Ohio, when "the sites of Rochester and Cleveland were both dark and gloomy forests, and Buffalo was a mere hamlet."‡ He returned to New England in the following spring, choosing on this occasion a more southerly route, through parts of Virginia, Maryland and Pennsylvania. This journey deserves special mention because it

* Address on the Scientific Life and Labors of William C Redfield, A.M., first President for the American Association for the Advancement of Science, delivered before the Association at their annual meeting in Montreal, August 14, 1857. By Denison Olmsted, with an engraved portrait on steel. Cambridge, 1858, p. 3.

† Idem, p. 5.

‡ Idem, p. 7.

was from the observations made by him then that he was able later to advocate with such remarkable power the great superiority of railroads to canals, and also the plan of a system of railroads connecting the waters of the Hudson with those of the Mississippi. In a pamphlet, which he issued in 1829, he startled the community by the boldness of his project. He says, referring to the territory east of the Mississippi :

This great plateau will, indeed, one day be intersected by thousands of miles of railroad communications ; and so rapid will be the increase of its population and resources, that many persons now living will probably see most or all of this accomplished.*

To the scientific world Redfield, however, is best known by his development of the law of storms. Essentially his theory was that a storm was a progressive whirlwind. For years he kept his theory to himself, and it was not till accumulative evidence established in his own mind the correctness of his convictions that he gave to the world, through the *American Journal of Science,* his valuable series of papers on that science which we now dignify by the name of meteorology.

Through the long years of his life Mr. Redfield was actively engaged in business, having established a line of two barges between New York City and Albany, and it was only such time as could be spared from more important pursuits that he devoted to the higher cause of science. The fossils, the ripple marks and the rain-drops in the sandstones of Connecticut and New Jersey interested him, and the papers which he read before this Association towards the close of his career pertained to his studies in geology. He died in New York City on July 12, 1857.

HENRY.

The selection of Joseph Henry, in 1846, to be the guiding hand of the then newly established Smithsonian Institution, made him, perhaps the most conspicuous representative of American science of his time. Henry was born in Albany just a century ago, and there he grew up and was educated. As a student, as a teacher, and as a professor, he was connected with the Albany Academy, and in that institution he carried on those researches in electricity which made the electromagnetic telegraph of Morse possible. In other words, Henry was the first to construct and use an electromagnetic acoustic telegraph of a type similar to that which is at present more generally employed than any other form. The code of signals now in general use had not at that time been invented.* In referring to his researches Sir David Brewster says: "On the shoulders of young Henry has fallen the mantle of Franklin." † In 1832 he accepted a call to the chair of natural philosophy, in Princeton, and for fourteen years led the peaceful life of a college professor in a rural university town.

Then came the call to Washington, and dubious as to the future, he said: "If I go I shall probably exchange permanent fame for transient reputation."‡ The path of duty was clearly defined, and yielding to the solicitation of his associates, such as Bache, Hare and Silliman, he accepted the appointment of secretary of the Smithsonian Institution. Of his career in Washington a contemporary says:

Called to administer the Smithsonian trust, his conscientious devotion gave it from the first the direction designed by the testator. His aim was to originate and disseminate. He scattered the seed broadcast, not through whim or favoritism, but on a matured plan. His

* Route of a Great Western Railway, 1829.

* Sketch of Joseph Henry, by G. Brown Goode, in The History of the First Half Century of the Smithsonian Institution. Washington, 1897, p. 134.

† Idem, p. 122.

‡ A Memorial of Joseph Henry, with an engraved portrait on steel. Washington, 1880, p. 276. Discourse of William B. Taylor.

place required a love of science, along with a talent for organization. He brought these to bear upon the origination of knowledge, and by his scientific sympathy and ready recognition of others of his guild, he commanded honest homage and became the director, helper, and umpire in scientific disputation. Did the War Department require his aid in meteorology? He gave the plan of weather signals. Did the Census Bureau ask his help? He planned the remarkable atlas as to rain-falls and temperature. Did the Coast Survey require scientific suggestions, or the Centennial Commissioners his judgment, or the new library and the 'School of Art' a friend and adviser; or the Light House board laws of sound for fogs, and cheaper and better illumination? He freely gave what was gladly welcomed. His institution gave Agassiz opportunity to study fishes, Baird, birds, and all students encouragement to investigate our American archæology and ethnology, as well as our fauna and flora.*

Those who are willing to know more of Henry's great work need only consult The Memorial Volume,† published by the Smithsonian Institution shortly after his death. I add the last sentences of Goode's sketch of him, which was published in the History of the First Half Century of the Smithsonian Institution:

What Franklin was to the last century, Henry is to this, and as the years go by his fame is growing brighter. The memorial service in his honor, held in 1878, in the hall of the United States House of Representatives, was a national event. In 1883 his monument in bronze, by the greatest of American sculptors, was erected by Congress in the Smithsonian Park. The bestowal of his name upon the unit of induction in 1893 was an indication of his foreign appreciation, while, as a still nobler tribute to his fame, his statue has been placed under the great rotunda of the National Library, the science of the world and of all time being symbolized by these two great men, Newton and Henry.‡

Beginning with 1850 the Association inaugurated the custom of holding a meeting in the spring of the year as well as one in the late summer. These earlier gatherings were held in the cities of the south and west, and the first of them, in March, 1850, was convened in Charleston, South Carolina, then a city of much scientific activity. Over this meeting Alexander Dallas Bache was chosen to preside.

BACHE.

Birth, education, and association combined to qualify Bache in an unusual degree for the many important duties to which he was called. He was the son of Richard Bache, one of the eight children of Sarah, the only daughter of Benjamin Franklin, and was born in Philadelphia in 1806. He was educated at the United States Military Academy in West Point and graduated at the head of the class of 1825 (of which he was the youngest member), with the unusual distinction of completing that rigid course of four years without receiving a single demerit. An appointment in the Corps of Engineers followed, and after serving a year as assistant professor of engineering at West Point, he was assigned to duty under Colonel Joseph G. Totten, in Newport, Rhode Island.

In 1829 he resigned from the army to accept the chair of natural philosophy and chemistry in the University of Pennsylvania, in Philadelphia, where he remained until 1843, leading a life of great activity, for he was a guiding influence in nearly every scientific movement in the city of his birth. He was appointed chairman of one of the most important of the committees of the Franklin Institute, and was chosen as the expounder of the principles of the Institute at its public exhibitions. He was an active member of the American Philo-

* Idem, p. 103. Address of Hon. S. S. Cox.

† A Memorial of Joseph Henry, Washington, 1880.

‡ The Smithsonian Institution, 1846–1896. The History of its First Half Century, Washington, 1897, p. 156.

sophical Society, and in his private observatory began that series of magnetic observations with which his name is so honorably connected.

His services in establishing the Girard College, of which he was the first president, and his development of the public school system of Philadelphia while filling the offices of principal of the high school and that of superintendent of the public schools, are best described in the statement that "the result of his labors in regard to the schools was the establishment of the best system of combined free education which had, at that time, been adopted in this country. It has since generally been regarded as a model, and has been introduced as such in different cities of the Union." *

Bache's great work, however, was in connection with the United States Coast Survey, to the superintendency of which he was called in 1843, and of his relation to that work I again quote from his biographer :

When Professor Bache took charge of the survey, it was still almost in its incipient stage, subjected to misapprehension, assailed by unjust prejudice, and liable, during any session of Congress, to be suspended or abolished. When he died, it had conquered prejudice, silenced opposition, and become established on a firm foundation as one of the permanent bureaus of the executive government. * * * He divided the whole coast line into sections, and organized, under separate parties, the essential operations of the survey simultaneously in each. He commenced the exploration of the Gulf Stream, and at the same time projected a series of observations on the tides, on the magnetism of the earth, and the direction of the winds at different seasons of the year. He also instituted a succession of researches in regard to the bottom of the ocean within soundings, and the forms of animal life which are found there, thus offering new and unexpected indications to the navigator. He pressed into service, for the determination of the longitude, the electric telegraph ; for the ready production of charts, photography ; and for multiplying copper-plate engravings, the new art of electrotyping. In planning and directing the execution of these varied improvements, which exacted so much comprehensiveness in design and minuteness in detail, Professor Bache was entirely successful.*

In Washington, as in Philadelphia, he was foremost in every movement, public or private, that tended towards the advancement of science. Besides being *ex-officio* superintendent of Weights and Measures, he was a member of the Lighthouse Board, and a regent of the Smithsonian Institution from its inception till his death. Nor can I omit mention of the fact that he was a Vice-President of the United States Sanitary Commission, and first President of the National Academy of Sciences. Professor Bache presided over the Charleston meeting in 1850, and also over the New Haven meeting in August, 1851, and over the Cincinnati meeting in May of the same year.

It is difficult at this time to determine when the unwritten law of the Association that a representative of the natural sciences should be chosen to succeed a representative of the physical sciences in the presidential chair came into existence, but with the election of Louis Agassiz, in 1851, as the successor of Bache, the principle was clearly indicated.

AGASSIZ.

With the possible exception of the elder Silliman, the influence of Louis Agassiz on the development of science in our country has been greater than that of any other single man. The extraordinary personal qualities of character as well as the talents and attainments of this great naturalist

* Eulogy on Professor Alexander Dallas Bache, late Superintendent of the U. S. Coast Survey, by Joseph Henry. Smithsonian Report for 1870, p. 98.

* Henry's Eulogy on Professor Alexander Dallas Bache, pp. 100, 101.

make any attempt of a brief sketch of his career almost impossible.*

The son of a Protestant clergyman, he was born in Switzerland, in 1807, and his early academic education was obtained in Bienne, Lausanne and Zurich, whence he passed to the great German universities of Heidelberg, Munich and Erlangen. Even in those days he was a leader. In Munich he was the presiding officer of the Little Academy, the members of which have since enrolled their names high on the tablets of fame. At the age of twenty-one, even before the doctor's degree had been conferred upon him, young Agassiz had secured 'a place among the best naturalists of the day'† by his work on the fishes of Brazil.

Delightful years in Vienna and Paris followed during which his dissipations were confined to the pleasures of association with the most distinguished men of his time, especially in Paris, where Humboldt was a conspicuous leader, and became his patron. Then, in 1832, he settled in Neuchatel as professor of natural history in the small college of that ever-charming little city. Students came to him; and among his associates of that time were Guyot and Pourtales, whom even the ocean could not separate from him. His 'Recherches sur les Poissons fossiles' in five quarto volumes, and his 'Etudes sur les Glaciers,' were given to the world during his residence in Neuchatel. The former is perhaps his most important contribution to natural science, and the latter a pioneer work in glacialogy.

In 1840 an invitation to deliver a course of lectures before the Lowell Institute in Boston was obtained for him through the interest of his friend, Sir Charles Lyell, and he agreed with Mr. John A. Lowell to give a course of lectures on the 'Plan of the Creation, especially in the Animal Kingdom.' He arrived in Boston in October, and in December delivered his first lecture. 'He carried his audience captive.'* From that time the well-worn 'Veni, Vidi, Vici' tells the story of his career in the new world. Enthusiastic audiences greeted him in New York, Philadelphia, Charleston, and elsewhere, and, yielding to the irresistible opportunities offered to him, he severed the ties that bound him to the land of his birth and accepted the chair of zoology and geology in the Lawrence Scientific School.

Guyot, his friend from boyhood, in speaking of the immense power he exerted in this country in spreading the taste for natural science and elevating the standard, says:

> How many leading students of nature are found to call themselves his pupils and gratefully acknowledge their great indebtedness to his judicious training? How many who now occupy scientific chairs in our public institutions multiply his influence by inculcating his methods, thus rendering future success sure.†

No better evidence of his success as a teacher is needed than that of the mere mention of his famous students. In addition to his son, Alexander, the names of Bickmore, Brooks, Clark, Fewkes, Hartt, Hyatt, Lyman, Morse, Niles, Packard, Putnam, Scudder, Shaler, Stimpson, Verrill, and Wilder, come readily to mind.

In this connection I want to quote from a letter of one of his students‡ who wrote me concerning his teaching as follows:

> The ideal of a young scientific student, and of every great teacher, is a devotion to scien-

*See Louis Agassiz. His Life and Correspondence, edited by Elizabeth Cary Agassiz, with portraits on steel, 2 vols. Boston, 1885.

† Biographical Memoirs of the National Academy of Sciences, Washington, 1886. Vol. II., p. 49. Louis Agassiz, by Arnold Guyot.

*'Life and Correspondence,' Vol. II., p. 496.

† Memoir by Guyot, p. 71.

‡ Dr. J. Walter Fewkes.

tific research for its own sake. Agassiz had that ideal extraordinarily developed, and on that account the student was drawn to him and felt in a corresponding degree a great influence on his life. Agassiz made many and important contributions to science, but the greatest of all was a life which embodied the ideal that scientific research is an unselfish study of truth for truth's sake. Every student who was brought in contact with Agassiz recognized this ideal, and was profoundly influenced by it.

The museum of Comparative Zoology in Cambridge, is his most conspicuous monument, but his influence, more powerful than bricks or mortar, will live forever.

A boulder from the glacier of the Aar marks his last resting place in Mount Auburn, and so 'the land of his birth and the land of his adoption are united in this grave.'*

The policy of holding two meetings a year was soon found to be unsatisfactory, and it was abandoned after the Charleston meeting in 1851. In consequence no spring gathering was held in 1852, and also no summer meeting was held during that year. It was not until July, 1853, that the Association again met, and then it was convened in Cleveland under the presidency of Benjamin Peirce.†

PEIRCE.

This distinguished mathematician, one of the greatest this country has ever known, was born in Salem, Massachusetts, in 1810. His father, whose name the son inherited, is best remembered as the historian and librarian of Harvard. In Cambridge the boy grew to manhood, and was graduated at Harvard in 1829 in the class that Oliver Wendell Holmes has so beautifully immortalized in one of his charming poems.

While in college he became a pupil of Nathaniel Bowditch, 'who made the prediction that young Peirce would become one of the leading mathematicians of this century.'* After graduating he began his career as a teacher and in 1831 returned to his *alma mater* as tutor in mathematics, becoming eleven years later Perkins professor of mathematics and astronomy, which chair he held until his death, 'when he had been connected with the university for a longer time than any other person except Henry Flynt, of the class of 1693.'†

His election to the presidency of our Association was probably a result of his connection with the United States Coast Survey, as in 1852 he had been assigned to the charge of the longitude determinations in that service. The successful prosecution of that work, in which he was associated with some of our most distinguished members, indicated him as the natural successor to the superintendency of the Survey itself on the death of Bache in 1867.

The paramount events of the civil war had, to a large extent, interfered with the regular work of the Survey, but under Peirce it was actively resumed. The plans laid down by his predecessor were taken up and the Survey extended to a great geodetic system, stretching from ocean to ocean, thus laying the foundations for a general map of the country that should be entirely independent of detached local surveys. With this object the great diagonal arc was extended from the vicinity of Washington to the southward and westward along the Blue Ridge, eventually reaching the Gulf of Mexico near Mobile. He also planned the important work of measuring the arc of the parallel of 39 degrees to join the Atlantic and Pacific systems of triangulation; and for determining geographical positions

* Life and Correspondence, Vol. 2, p. 783.

† See Benjamin Peirce. A Memorial Collection, by Moses King, Cambridge, 1881, p. 18, with an engraved portrait on wood.

* Cyclopedia of American Biography, Vol. VI., p. 701 New York, 1888. Article on Benjamin Peirce written by myself.

† Memorial Collection.

in States where geological or geographical surveys were in progress.

Only an astronomer can follow the mathematical intricacies of Peirce's remarkable announcement concerning the discovery of the planet Neptune.

This Planet [says President Hill] was discovered in September, 1846, in consequence of the request of Leverrier to Galle that he should search the zodiac in the neighborhood of longitude 325°, for a theoretical cause of certain perturbations of Uranus. But Peirce showed that the discovery was a happy accident; not that Leverrier's calculations had not been exact, and wonderfully laborious, and deserving of the highest honor, but because there were, in fact, two very different solutions of the perturbations of Uranus possible: Leverrier had correctly calculated one, but the actual planet in the sky solved the other; and the actual planet and Leverrier's ideal one lay in the same direction from the earth only in 1846. Peirce's labors upon this problem, while showing him to be the peer of any astronomer, were in no way directed against Leverrier's fame as a mathematician; on the contrary, he testified in the strongest manner that he had examined and verified Leverrier's labors sufficiently to establish their marvellous accuracy and minuteness, as well as their herculean amount.*

His greatest contribution to astronomy, however, was in connection with the rings of Saturn. He demonstrated that the rings, if fluid, could not be sustained by the planet, that satellites could not sustain a solid ring, but that sufficiently large and numerous satellites could sustain a fluid ring, and that the actual satellites of Saturn were sufficient for that purpose.

Peirce was a teacher, and his teaching is referred to by one of his students as 'the most stimulating intellectual influence I ever encountered.' † As an executive officer in charge of the coast survey, and also of the *American Ephemeris*, it is said that:

The reports of that survey and the tables of the *Ephemeris* have rapidly raised the scientific reputation of America, which, in 1843, stood in astronomy among the lowest of civilized nations, and is now among the highest—a change which was by no means ungrateful to Peirce's strongly patriotic feeling, and which he could not but know was as much due to himself as to any other person.*

As a mathematician it was said at the time of his death that "the late Professor Peirce's merits will rank with the marvellous achievements of Bernoulli, Euler, and Laplace." †

President Hill closes his sketch of Peirce with the following words:

While Professor Peirce has the tenacity of grasp, and power of endurance, which enable him to make the most intricate and tedious numerical computations, he is still more distinguished by intensity and fervor of action in every part of his nature, an enthusiasm for whatever is noble and beautiful in the world or in art, in fiction or real life; an exalted moral strength and purity; a glowing imagination which soars into the seventh heavens; an insight and a keenness of external observations which makes the atom as grand to him as a planet; a depth of reverence which exalts him while he abases himself. ‡

I prefer the stanzas of Holmes' Memorial poem, beginning with:

> To him the wandering stars revealed
> The secrets in their cradle sealed;
> The far-off, frozen sphere that swings
> Through ether, zoned with lucid rings;
>
> The orb that rolls in dim eclipse,
> Wide wheeling round its long ellipse,—
> His name Urania writes with these,
> And stamps it on her Pleiades.§

It was at the Toronto meeting just ten years ago that the Association was honored

* Thomas Hill in The Memorial Collection, p. 8.

† Thomas Wentworth Higginson, in The Memorial Collection, p. 31.

* *The Nation*, New York, October 14, 1880.

† *Boston Daily Advertiser*, October 7, 1880.

‡ The Memorial Collection, p. 11.

§ *Atlantic Monthly*.

by the presence of its then oldest living past president in the person of James Dwight Dana, who in 1854, presided over the meeting held in Washington.

DANA.

Dana was born in Utica, New York, in February, 1813, and as a boy showed a taste for natural science, making frequent excursions after minerals with his school companions. Attracted by the name of the elder Silliman, then at the height of his powers and reputation, he went to New Haven and entered Yale. As an undergraduate it is said that 'he made much progress in science, especially in his favorite study of mineralogy.'*

The influence of the master was irresistible, and he decided to devote himself to science, and, as if to confirm his decision, an opportunity presented itself even before he had graduated, for in 1833 he accepted an appointment as instructor in mathematics in the United States Navy. For more than a year he cruised in European waters, chiefly on the Mediterranean, devoting his leisure to studies of the interesting features of geology and natural history that presented themselves.

He returned to New Haven in 1836, and became an assistant to Silliman. It was at this time, in May, 1837, that he published the first edition of his System of Mineralogy. Scarcely had that work been given to the public than he received an invitation to become the mineralogist and geologist of the United States Exploring Expedition, about to visit the Southern and Pacific Oceans under Captain Charles Wilkes. In August, 1838, the expedition started from Norfolk, Virginia, and reached New York on its return in June, 1842. For thirteen years thereafter Dana devoted himself to the study of the material that had been collected, and to the preparation of his reports, of which those on the Zoophytes, the geology of the Pacific, and on the Crustacea were published.

*See James Dwight Dana, a biographical sketch, with a half-tone portrait, and bibliography, by E. S. Dana in the *American Journal of Science*, third series, Vol. XLIX., p, 329, May, 1895.

Meanwhile he accepted the appointment to the Silliman chair of natural history and geology in Yale, but did not assume the active duties of the professorship until 1855.

From this auspicious beginning his active connection with Yale continued until it was interrupted in 1890 by a serious illness, after which, failing strength and advancing years made it impossible for him to resume his professorial duties, and in 1894 he was made professor emeritus.

The year 1818 is conspicuous in the history of the development of science in this country by the founding of the *American Journal of Science*. From its inception until his death the name of Benjamin Silliman appeared on its title-page as senior editor. In 1846 to that name was added that of the younger Silliman and Dana as associate editors. Of these three Dana was the survivor, and from 1875 till his death he was its senior editor.

In 1893, on the occasion of his eightieth birthday, a congratulatory letter from his scientific colleagues in New Haven made mention of his editorial career as follows:

> The long series of volumes of this periodical are a noble monument of the extent and thoroughness of your labors as a naturalist.*

It is fortunate for American science that this journal has been handed down as a precious legacy to the grandson of its founder, Edward S. Dana, under whose able guidance, let us hope, that it may long continue.

Wherever mineralogy or geology is taught, the unsurpassed text-books on these subjects by Dana, hold easy supremacy. His

*SCIENCE, New Series, Vol. I., p. 489; May 3, 1895.

System of Mineralogy, first published in 1837 as a volume of 580 pages, passed to a second edition in 1844, a third in 1850, a fourth in 1854, and a fifth in 1866, when it had increased to 827 pages. The later editions were prepared by his son. To these must be added four editions of his smaller Manual of Mineralogy, the last of which appeared in 1887, and was a duodecimo volume of 518 pages. Of his mineralogy, Powell says:

Thus he was the first to give us a system of mineralogy; but his work in this field did not end at that stage. He still pursued his investigations, collecting from many fields and drawing from the collections of many others in many lands, until at last he developed a new system of mineralogy, placing the science on an enduring basis. This accomplishment alone was also worthy of a great man, and by it a new science was organized on a mathematical, chemical and physical basis.*

The broader field of geology became his after his return from the exploring expedition, and he published his Manual of Geology in 1862. Of this work one of his colleagues says:

The treatment of strata and fossils from a chronological point of view as historical geology is a characteristic feature of this manual. The growth and development of the earth, its continents and seas, and the progress in the organic life on its surface, were thus unified into a special department of geology, the history of the earth and of its inhabitants, which was by other authors dealt with as formational, stratigraphic, or paleontologic geology.

He prepared four editions of this work, the last of which appeared early in 1895, shortly before his death. As with his mineralogy he prepared an elementary textbook of geology, of which two editions were published. Concerning his valuable work on geology, Powell said:

So Dana's Geology is not only a text-book of geology, but it is the hand-book for all National, State and local geologists, and all students in the field. It is the universal book of reference in that department of science. Other textbooks have been developed but no other handbook for America. It is a vast repository of facts, but all arranged in such a manner as to constitute a geologic philosophy. It is on every worker's table and is carried in the kit of every field observer. It has thus become the standard to which all scientific research is referred, and on which geologic reports are modeled.*

Besides the foregoing, Dana was the author of Coral Reefs and Islands, which he enlarged and published later as Corals and Corals Islands; of The Geological Story Briefly Told; The Characteristics of Volcanoes; and The Four Rocks of the New Haven Region.

In conclusion Powell says of him:

Dana as a zoologist was great, Dana as a mineralogist was greater, but Dana as a geologist was greatest, and Dana in all three was a philosopher; hence, Dana's great work is enduring.†

The ninth meeting of the American Association was held in Providence, Rhode Island, and over that meeting John Torrey, 'chief of American botanists,'‡ presided.

TORREY.

Torrey was born in New York City in 1796, and was the son of Captain William Torrey, of the Continental army, from whom he inherited the much-prized eagle

* Memorial address on James Dwight Dana before the Scientific Societies of Washington, by John W. Powell, Science, New Series, Vol. III., February 7, 1896, p. 183.

* Powell, op. cit., p. 184.

† Idem, p. 184.

‡ Biographical Memoirs of the National Academy of Sciences, Washington, 1886, Vol. II., p. 267. John Torrey, by Asa Gray. In addition to the foregoing a sketch of Torrey accompanied by an engraved portrait on wood is contained in the *Popular Science Monthly*, Vol. III., p. 632. Also his portrait can be found in a History of the New York Academy of Science, by Herman Leroy Fairchild, New York, 1887.

of Cincinnati. His mother was also of an old New York family. The boy was educated in his native city, and from Amos Eaton he learned 'the structure of flowers and the rudiments of botany.'* An education must have a broadening influence, and as he grew in years his interest in botany extended to chemistry and mineralogy, and finally to medicine, in which he was graduated from the College of Physicians and Surgeons in 1818. The practice of his chosen profession was not altogether congenial to him, and turning again to botany he began his Flora of the Northern and Middle United States. He published a portion of this work in 1824, and then accepted an appointment as assistant surgeon in the United States Army in order to become professor of chemistry, mineralogy, and geology in the United States Military Academy at West Point.

His abilities as a teacher received ample recognition, for in 1827 he was called to the chair of chemistry and botany in the College of Physicians and Surgeons, which he held until 1855. In 1830 he accepted the professorship in chemistry in Princeton, which he retained until 1854. These various collegiate appointments were then made *emeritus*, for on the establishment of the United States Assay Office in New York, in 1853, he was called to the charge of that place and held it until his death, twenty years later.

Gray says:

> It must not be forgotten that he was for more than thirty years an active and distinguished teacher, mainly of chemistry, and in more than one institution at the same time; that he devoted much time and remarkable skill and judgment to the practical applications of chemistry, in which his counsels were constantly sought and too generously given.†

The foregoing quotation becomes especially significant when we remember that his botanical work, yet to be referred to, was accomplished in the intervals of his busy life. In 1836 he was appointed botanist to the State of New York, and in 1843 issued the two quarto volumes of which it has been so well said: "No other state of the Union has produced a flora to compare with this."* Prior to the organization of the special scientific bureaus in Washington, with their large staffs of competent specialists, it was the practice of the government to refer the material collected by exploring expeditions to those most competent to report on it, and the botany in those years for the most part was assigned to Torrey. He reported on the specimens collected by Captain John C. Frèmont in the expedition to the Rocky Mountains in 1845; on the plants gathered by Major William H. Emory on the reconnaissance from Fort Leavenworth, Missouri, to San Diego, California, in 1848; on the specimen secured by Captain Howard Stansbury on his expedition to the Great Salt Lake of Utah, in 1852; on those collected by Colonel John C. Frèmont in California, in 1853; on those brought back from the Red River of Louisiana, by Captain Randolph B. Marcy, in 1853; and those obtained by Captain Lorenzo Sitgreaves on his expedition to the Zuñi and Colorado Rivers, in 1854. Then followed his elaborate memoirs on the botany of the various expeditions connected with the Pacific Railroad Survey during the years 1855–1860; the Mexican Boundary Survey in 1859, and the Colorado River Expedition in 1861. It was this succession of magnificent monographs on the flora of North America that gained for him an imperishable reputation among the greatest of American botanists.

His associates have honored his name by giving it to certain species of shade trees, and so all round the world *Torreya taxifolia*,

* Gray, op. cit., p. 268.
† Idem, p. 273.

* Idem, p. 271.

Torreya californica, *Torreya nucifera*, *Torreya grandis* preserve his memory as green as their own perpetual verdure.*

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM.

(*To be continued.*)

THE HISTORY OF THE BEGINNINGS OF THE SCIENCE OF PRE-HISTORIC ANTHROPOLOGY.

II.

Paleolithic Age in the United States.

The existence of the paleolithic stage of culture in America has been doubted, and, indeed, strenuously denied by some of our scientists who are well up in archeology and prehistoric anthropology.

My somewhat extensive travels with long stops and continuous examinations of many of the localities in Europe occupied by paleolithic man, especially among the caverns of the Dordogne district; my personal acquaintance with most of the collections of paleolithic implements made in these countries; my association with the leading investigators and believers in paleolithic occupation, have fitted me in a degree to judge of the subject which it would be mock modesty on my part to deny; while my dozen years' service in the prehistoric department of the U. S. National Museum, gives me an acquaintance with the American specimens by which I may compare the specimens from the two countries in a peculiar manner which I hope is not without its value.

The original discovery of a paleolithic period was made in Europe. The determining characteristics of that period have been decided only in Europe, and it must be principally by comparison with the evidence there that we are to determine the existence of a corresponding period in America. This evidence is furnished (in Europe) largely by geology and by paleontology. As has been described, discoveries of the remains of man, either physical or industrial (technologic), have been made in, and belong to, quaternary deposits, determined either by the geologic strata in which they were found, or the paleontologic objects with which they were associated. This species of evidence is, to a considerable extent, lacking in America. The European conditions have been found to exist in but few localities; yet America is not entirely without instances. Dr. Koch found a mammoth skeleton in Missouri, associated with which were flint weapons of human manufacture. It and the weapons are now displayed in the Berlin Museum. Dr. Dickeson found at Natchez, Mississippi, the buried skeletal remains of a megalonyx superposed on a portion of a human skeleton. The human skeleton from Guadeloupe, now at Paris, was encased in coquina, a rock made of shells belonging to the quaternary, though not exclusively so. The Iron Man of Sarasota Bay, Florida, found by Judge John G. Webb, was completely fossilized and changed to limonite. A fossilized human calcaneum was found by Col. Joseph Wilcox, of Philadelphia, in the same neighborhood with a quaternary shell forming part of the mass. Three similar instances were found in the same country in separated localities, showing them to have been different individuals; some of these have been encased in bog iron ore, others in indurated sandstone apparently as solid as though formed at the bottom of the ocean. The Nampa Image has been cited as evidence of high antiquity of man in America, and while its genuineness has been questioned, the attacks upon it are far from being successful.

The Calaveras skull has been the subject of much hilarious scientific criticism bordering on contempt. The facts of its discovery should be subjected to painstaking and detailed investigation before the results of

*Gray, op. cit., p. 276.

those facts are assumed. Whatever may be the conclusions concerning the fraudulent character of this specimen based upon its alleged 'planting' by contemporary miners, as a practical joke to 'fool Professor Whitney,' it should be remarked that the evidence favoring this charge is itself open to as grave suspicions as is the rankest fraud ever perpetrated. The geologic changes of that country have been so great, that it requires the gravest consideration and an intimate study or knowledge of all the facts before any one is justified in passing upon the archeologic question. I cannot here or now investigate the subject from either of these view points. I am not a geologist and I have never visited the locality. I can only suggest some of the points to be considered before a conclusion is reached, and raise a warning or danger flag to those who would decide against the authenticity of the specimen on insufficient or *a priori* grounds.

The Stanislaus river, at the time of the deposition of the lava and gravel in which the skull was found, ran down the side of Table mountain in the same neighborhood in which it now runs, but its valley was then some fifteen hundred feet higher than at present; that is, since the valley of the Stanislaus was choked up and the water turned aside by the eruption of lava and the deposit of cemented gravel, the deflected river has cut or eroded a new channel fifteen hundred or more feet deeper into the earth than was the earlier channel. This will give some idea of the immensity of time and the great surface changes with which we have to deal. Many implements and objects of undoubted human origin have been found in divers localities in California, alleged to have been imbedded in the same kind of gravels and to have formed part of similar deposits. It is part of the argument against the Calaveras skull to assail the authenticity of their discovery. First it was charged that these finds were made by miners, laymen, ignorant and unaccustomed to recognize or describe them with scientific accuracy; but this was answered when Professor Clarence King, then head of the Geological Survey of the United States, and the highest scientific authority, found one of the pestles *in situ*, imbedded in the cemented gravel under the lava cap, that he recognized its character before he exhumed it, and in view of the importance of the question involved, proceeded with care to dig it out. He preserved it, brought it to Washington, and placed it in its lawful depository, the U. S. National Museum, where it now is. It is remarkable that similar implements and objects to the number of about three hundred should have been found, alleged by their finders to have been dug out of the gravels under the lava cap in various localities in California—it is remarkable, I say that these should all have been frauds, and their finders either swindlers and liars, or else have duped themselves by their own discoveries. California miners have been generally credited with more astuteness than to be their own dupes, while it is curious if a whole state or a whole class within a state should combine in a general swindle and lie, out of which no profit, present or prospective, was possible. The objection has been made that these implements are polished or ground, at least pecked or hammered ready for polishing, therefore belong to the Neolithic or polished stone age; and this it is alleged is incompatible with their great antiquity. Some American archeologists assert that chipped stone implements were more difficult to make than polished ones, and on the well-recognized principle that the simplest and easiest way was the earliest, while the more complex and difficult ways came later, they insist with pertinacity that European classification is erroneous, and that the relative chronological positions

of the Paleolithic and Neolithic ages should be reversed. This view, if accepted, would satisfactorily explain the apparent anomaly of the California implements. The real answer to this objection is that we know but little concerning California prehistoric archeology. It presents many problems which have not been solved, nor indeed do we seem to be in the way of solving them. Some of these are as follows :

The Indian languages of the Pacific slope have peculiarities as yet unexplained. A A fringe of country lying between the coast range and the ocean contains a greater number of stocks or families of languages (29) than all the rest of North America combined.*

The reason for this has never been explained even theoretically or tentatively. The arrowpoints and spearheads of the Pacific Coast are notably different from those of other parts of the country. To such extent is this true that in my classification of these implements and weapons† I was compelled to make a separate class for the accommodation of the implements from this district. Pottery, forming the most serviceable, and which might be considered the most important, domestic utensils, and as such used by nearly all prehistoric and primitive peoples, makes complete default on the Pacific Coast; this, too, while their neighbors, the natives of Mexico and the Pueblo country, even the wild and savage Papagos, make and use it continually, some being of the largest forms with the finest decorations. Basketry in some cases supersedes pottery for carrying liquids, and the finest in America and perhaps in the world, either in ancient or modern times, are to be found on the California coast.‡

* See Major Powell's Linguistic Map; Seventh Annual Report of the Bureau of American Ethnology, 1885–86, pp. 7–142.

† Report of the U. S. National Museum, 1897.

‡ See the Hudson Collection just purchased by and now in the U. S. National Museum.

The ollas (carrying or cooking jars taking the place of pottery) are made of stone (serpentine) instead of clay. These are some of the California anomalies. When the problems presented by them have been satisfactorily solved, that relating to polished stone implements may not appear so difficult.

It has been objected that the stone implements of seemingly so high antiquity were not water worn and bore no traces of long or distant transportation by the mountain streams. An answer is patent. There is no evidence that they were transported or rolled any distance by water, and until this fact be established, there is no need to attempt the demonstration of its cause. We should establish the fact before we explain its cause.

The study of California archeology, in order that it be satisfactory, requires a union of three scientists : the archeologist, the geologist, and the historian who shall act as lawyer and judge. The Calaveras skull incident has closed, has passed into history, and its facts are to be determined by evidence, the same as any other fact in history. The first question is, did Mattison actually find the skull as he says he did? and second, had it been planted in order to 'fool Professor Whitney'? I think if this issue was made up to be tried before a court and jury on the lawful evidence submitted, the answers would be in the affirmative on the first question and negative as to the second. Until this issue is determined, it is folly to try the case by popular clamor and to denounce its possible believers or pour vials of contempt and contumely upon their heads.

Because I have favored the authenticity and genuineness of specimens which have been assailed, I would not have it understood that I am deluded into the belief that all specimens are genuine. I recognize that frauds have been committed, that

fraudulent specimens have been manufactured, planted, dug up and sold as genuine, and that great deceptions have been practiced. I have not hesitated to attack and destroy their claims whenever presented. But I here contend that in passing on the genuineness of specimens, we should decide fairly and honestly. We should first get possession of all the facts, sift them to their last residuum of truth, and, giving each fact its fair and due weight, decide the question according to our best and truest judgment. This should be done 'without prejudice or preconceived opinion.' It is unfair to decide such questions in advance of knowledge of the evidence; it is unscientific to decide *a priori* that so-and-so is true because it must be true, and so-and-so is not true because it can't be true. I heard one who claimed to be a prehistoric anthropologist say that he would not believe a certain object to be a genuine find if he had found it himself. It is obviously impossible to argue with, much less convince, such a man. In determining these contested questions, I have ever sought to be impartial and, above all things, honest. It is only thus that we can hope to arrive at the truth.

Boucher de Perthes's discovery of paleolithic implements in original and undisturbed quaternary river gravels has been described in its appropriate place in this address.

After the proposition that these were remains of human industry had been accepted, the European investigators drew deductions based on the similarity of objects and implements found in other localities where the geologic or paleontologic evidences were not so plain or so plentiful, and the finding of paleolithic implements alone has been accepted as evidence of human occupation during that period. The same practice has been pursued in America. The deposit at Trenton, New Jersey, is accepted by geologists as belonging to the quaternary period; and while the finding therein of paleolithic implements or human remains has been disputed, it seems to have occurred so often, and these finds to have been so numerous that it cannot long continue to be denied. The discovery of a mammoth tusk in the Trenton gravels, now on exhibition at Rutgers College, New Brunswick, N. J., is confirmatory evidence not to be overlooked or lightly regarded. I do not propose to enter into a discussion of the weather beaten subject of the Trenton gravels. I presented a paper before this section at the Detroit meeting,* by which I still stand. The same sort of evidence is furnished by the Tuscarawas specimen found by Mr. Mills in the glacial till of Ohio, and described by Professor Wright.† Likewise the implement found by Dr. Hilbourne T. Cresson, Delaware, and made the subject of a paper by Professor Wright, read before this Section at this meeting.

The chapter on High Plateau paleoliths deals with paleolithic chipped flint implements found in England on the surface; others of the same nature have been found, still on the surface, in France on the high plateaux between the rivers Seine and Yonne. These have been recognized by every one who is competent to have an opinion, as true paleoliths. The same condition applies to certain localities in the United States, that is to say, on the plateaux on the headwaters of certain rivers beyond the erosion by which the valleys were formed. So there have been found on the surface in the United States many chipped flint implements which from their size, shape, appearance and mode of manufacture, are identical to the smallest detail with the

* Published in Volume XLVI., 1897, pp. 381–383, of the Proceedings.

† *Popular Science Monthly*, July, 1891, Vol. XXXIX., No. 3, pp. 314–319. *Man and the Glacial period*, pp. 251–3.

recognized paleolithic implements of Europe. These are dissimilar to the prehistoric implements of every other period in any country, and if there is any force or truth in the argument of similarity of culture from, or by reason of, similarity of implements, between two widely separated peoples using them, this would seem to establish the existence of a paleolithic period in America as well as in Europe. Dr. Brinton and Professor Putnam, though occupying antagonistic positions on many of these questions, both seem to concede the antiquity of man on the American continent.

Dr. Brinton's address heretofore mentioned, contains two or three pregnant sentences on the subject of man's antiquity in America which, coming from him, are noticeable, and I quote them approvingly:

> There is, however, a class of monuments of much greater antiquity. * * * These are the artificial shell heaps which are found along the shores of both oceans and many rivers in both North and South America. They correspond to the kitchen middens of European archeology. * * * The shells are by no means all of modern type. Many are of species now wholly extinct, or extinct in the locality. This fact alone carries us back to an antiquity which must be numbered by many thousands of years before our era. * * * This class of monuments, therefore, supply us data which prove man's existence in America in what some call the diluvial, others the quaternary, and others again the pleistocene epoch, that characterized by the presence of extinct species.

Professor Putnam, in his address at this meeting said:

> That man was on the American Continent in quaternary times, and possibly still earlier, seems to me as certain as that he was in the Old World during the same period.

Antiquity of the Red Race in America.

Not to split hairs over names, I suppose we should all agree upon the generic name of 'Red Race,' and as I have some definite opinions as to the antiquity of the red race in America, I may make a *résumé* of my position.

If we accept the theory of the unity of the human species and its origin from a single stock, we must agree that the human species either originated on the Western Hemisphere and migrated to the Eastern, or else the reverse. Whether it originated in America or came here by migration, the conclusion seems irrefutable that it started with but comparatively few individuals, they occupied but one, or few localities, they grew to have practically the same industries, and they spoke practically the same language. Professor Putnam* contends that there was more than one race and so there may have been more than one migration and more than one colony. This, if accepted (and I make no dispute over it), does not materially affect my proposition. There were surely but few colonies with but few members in each. From these small beginnings, the red race had, prior to the discovery of America, spread over the entire Hemisphere, from the Arctic Ocean to Terra del Fuego, and from the Atlantic to the Pacific; it had increased, we can only suppose in the natural way, from a single pair or score or possibly a hundred individuals, to the seven or eleven millions which are said to have been the numbers at the time of Columbus's discovery; and their migrations had been sufficiently extended and the separation sufficiently pronounced and maintained, as that the language originally spoken had increased to the great number of which we now know.†

There is a difference or distinction in the ground or polished implements and objects of the ancient man of North America, which indicates a high antiquity. The Indian made and used, at the time of the discovery, certain implements and objects

*See his Presidential Address.

†The Bureau of American Ethnology estimates the number of the different stock languages at fifty-six among the American Indians; while the number of dialects is estimated at two hundred and over.

which have been continued in modern times by which he can easily be recognized and identified. Many of these are of the same type as those in Europe in neolithic times. But there are certain others, also ground, polished and drilled, some showing a high order of mechanism, art and industry, which had gone out of use and had become prehistoric among the Indians themselves. They have been found in mounds and show a pre-Columbian and ancient origin. The objects referred to are usually of the class termed ceremonial: bannerstones, bird-shaped, boat-shaped, spade-shaped, gorgets, tablets drilled or inscribed, sinkers, pendants or charms, tubes and certain specimens of stone pipes. The mounds themselves indicate a great antiquity, but their building and use seems also to have continued into later and possibly into modern times. The antiquity of the mounds has been a subject of great contention, but I refer to a foregoing quotation from Dr. Brinton,* and also the address of Professor Putnam delivered at this meeting (p. 73), where he says:

> Many of these shell mounds are of great antiquity * * * and cannot be regarded as the work of one people. * * * Thus it will be seen that the earth mounds, like the shell mounds, were made by many people and at various times. * * * So far as the older earthworks, such as Newark, Liberty, Highbank and Marietta group, the Turner, the Hopewell group, the Cahokia mound of St. Louis, the Serpent mound of Adams County, Forts Ancient and Hill and many others, have been investigated, they have proved to be of considerable antiquity. This is shown by the formation of a foot or more of vegetable growth upon their steep sides, by the primeval character of the forest growth upon them, and by the probability that many of these works, covering hundreds of acres, were planned and built upon the river terraces before the growth of the virgin forest.

If the above facts in regard to the origin of man on the Western Hemisphere be accepted as true (and it is difficult to see how they can be evaded), the conclusions announced of the minimum high antiquity of man in America seems incontrovertible; and I am glad to stand with Dr. Brinton and Professor Putnam in maintaining the same conclusion, however much we may differ as to the arguments by which it is reached.

We have assumed a migration from the Eastern Hemisphere as a means of accounting for the human occupation of the Western; how it comes that the human product in the Western Hemisphere should be different from its progenitors in the Eastern, is not involved in this discussion. The question belongs to the earlier one of the origin of races. If we question how the Red Race of America could have sprung from either one of the three or four races of the Eastern Hemisphere, we are involved in equal obscurity as to how the three races of the Eastern Hemisphere should have sprung from a single stock, assuming, as we have, the unity of the human species. The discussion of this question is not here pertinent; it belongs to another branch of the science of anthropology and is to be discussed otherwheres. If we accept the theory of the unity of the human species and that they all sprung from one stock, the conclusion may as well be accepted as to the formation of the Red Race in America, as to the Yellow in Asia, the White in Europe and the Black race in Africa. The problem of the peopling of America has been dealt with theoretically by M. de Quatrefages in his 'Historie Generale des Races Humaines,' wherein he assumes a combination of thirty individuals of the Yellow, twenty of the White, and ten of the Black race, who, placed on the common basis of an isolated colony anywhere in the Western Hemisphere would, by amalgamation and procreation, produce a race with the principal characteristics of the Red.

* Ante, p. 73.

Migrations of the Red Race in America.

Continuing our stand on the theory of the unity of the human species, we recognize that all the different races must have sprung from one stock, and this could have been done only by the most intimate physical connection. No theory of similarity of human thought and need will even assist in explaining this fact. The difficulties of migration all disappear before it; distances of time and place are as nothing. On the basis that the human species sprang from a single stock, the conclusion is not to be evaded that all the races, the Red among the rest, descended from the stock, generation after generation, from father to son and from mother to daughter; and this must have been true from the time of the first human pair down to those born in A. D., 1899. This proves the communication and relationship between all individuals of the human species and *a priori* that all human occupation of different countries, or passages from one country to another must have been accomplished by migration.

On this subject Sir John Lubbock (Prehistoric Times, p. 587) says:

> Assuming, of course, the unity of the human race, there can be no doubt that men originally crept over the earth's surface, little by little, year by year, just, for instance, as the weeds of Europe are now gradually, but surely creeping over the surface of Australia.

On this assumption, the questions of human migration, and with it the migration or importation of human industries, settle themselves. If the people migrated, they carried their industries with them. Their knowledge of implements, utensils and weapons, and how to make them, ought to be substantially the same in both countries, the country of immigration as in the country of emigration, and this we find to be true.

If the prehistoric man migrated from the Eastern Hemisphere to the Western, and commenced his occupation at the early period, the Paleolithic, as suggested by Dr. Brinton and as indicated by the possible existence here of paleolithic implements, he must have brought with him the knowledge of paleolithic industries, whatever those may have been. He may have come over in the Paleolithic period and had either a continued communication or a renewal of the migration. If his migration or the renewal thereof was not until the Neolithic period, then he brought with him the knowledge of that period. If we are to determine this by the similarity of industries, we would say that the last migration in prehistoric times was during the Neolithic period. Waiving for the moment any discussion as to whether the man of the Neolithic period was still in the savage stage of culture or had advanced to the barbaric, it is remarkable that the industries between the two countries should have been so nearly identical. Nearly every industry that would belong to a savage or barbaric people which might be regarded as necessary to their comfort if not their existence, is found in both Hemispheres, and in both substantially alike. In many industries, that is in the making and use of many implements, utensils, or weapons, they were exactly alike. There was in these cases, an absolute identity; the differences were not greater between the implements, etc., of the two Hemispheres than between those of any two countries in the same Hemisphere.

Similarity of Human Culture no Evidence of Similarity of Race, but is of Communication.

The similarity between man's culture in Europe during the Neolithic period, and that in America during the pre-Columbian period, extended to nearly every industrial object of importance relating to the lives of the two peoples. Nearly everything relating to tools or implements which one gen-

eration or one people could teach another, existed in both countries. I speak, not of the tastes, habits, customs, folk-lore, games, traditions, religions, beliefs, etc., which may or may not have been continued from one country to another, these may have perished or been lost in transmission; but I speak of the serious things of life, those which go to make epochs of culture, which determine civilization, questions involving sustenance of life, such as implements, utensils, weapons, the means by which life was maintained and made possible. I may speak, also, of the tools with which these implements were made and the method of their manufacture.* The lines on which this parallel are drawn are so broad as to include practically all savage or barbarian needs. The industries of chipping, battering, pecking, grinding, polishing, sawing and drilling were all applied to stone, bone, horn and wood, and were identical in Europe and America. The implements made from these materials and by these methods were similar, if not identical, in the two countries: stone hatchets, bow and arrows, spearheads, knives, scrapers, grinders, mortars and pestles, gouges, chisels, hammers. There is not more difference between these tools in the two Hemispheres than there is between them in any two countries in the same Hemisphere. A series of polished stone hatchets from Scioto Valley, Ohio, will, save only the difference in material, correspond favorably in form, size, mode of manufacture and possible use, with a like prehistoric series from almost any other country in the world. The same is true of all the implements mentioned in the list above. Pottery, which figures so extensively in the life of primitive man, was substantially the same in the two Hemispheres; spindle-whorls and thread, on which depended the art of weaving, and all the paraphernalia of nets and snares for catching game; these, like the others, were practically the same in both Hemispheres. There were differences in size, weight, material and ornamentation, but throughout the prehistoric period, they were substantially the same utensils. We find plenty of prehistoric weaving, more in Europe than in America, probably because the latter peoples wore clothing and made tents of skins; but the invention and use of the loom by which the product of the spindle-whorl could be utilized, was a machine of great intricacy and difficulty of manufacture. This intricacy and difficulty becomes magnified when we consider that the loom and the spindle-whorl form together but parts of the same machine and that to a large extent each depended on the other. When we find the machines and their products practically the same in both countries, it is an argument of great weight and carries with it a power of conviction.

* The architecture and possibly the sociology of the Aztecs in Mexico and the Incas in Peru should be excepted from this general statement and subjected to special investigation.

One of the important industries in primitive life, whether savage or barbarian, was the treatment of skins of animals for tents or clothing. The first and most necessary implement for the treatment of skins is the scraper, and this is as true of the modern tannery as it was in the time of the shepherds on the plains of Chaldea. The scrapers of Europe and America are identical. The skins of prehistoric times in both countries, whether of tents or of clothing, have perished, and no traces of them are found; but the flint scrapers remain as a satisfactory and convincing evidence of the treatment of the material, and that in this, the early men of Europe and America were alike.

Lest some critic should pick a flaw in the foregoing statement of facts, I mention the teshoa, a kind of scraper peculiar to the foot-hills on the eastern slopes of the Rocky

Mountains. It has been described by Professor Leidy, and specimens have been sent to the museum by Col. P. H. Ray. They were spauls from boulders, with a sharp edge, and were knocked off by the Indians during their buffalo hunts, used temporarily and left. This is believed to be the only exception to the universality of the stone scraper of the Neolithic age anywhere throughout the world.

Speaking of the similarities between the industries and implements of the two Hemispheres, I have used the term 'identical,' and the word is correct. There may be a difference in detail, arising from the separation of time and distance, but with all that, they were the same industries, the implements were the same, made of the same kind of material, by the same process and to serve the same purpose. If there is a difference between these industries and objects in the two Hemispheres, it is like the difference between the present fashion in dress in France and in the United States. But there will be a difference between the fashions of Paris and London or, to make it more patent, between the city-folk and the peasants, whether of France, Holland, Sweden, Scotland or Ireland. So are there differences between the fashions of the various cities or states in the United States; yet in all these countries, among all these peoples, however widely separated they may be, the difference is only of fashion; and all the costumes worn are at last the same articles of dress. This is a fair illustration of the differences between the stone hatchets or the arrowpoints and spearheads of prehistoric times in the countries named.

In Europe the stone hatchet was inserted in its handle, though there may have been variations of the mode of fastening. Arrived in America, we find the same stone hatchet, handled also by insertion. When the European neolithic man wanted an axe or a heavier chopping or splitting implement, he drilled a hole through the axe and inserted a handle, sledge-fashion. The prehistoric American did not adopt this style. He made a groove and tied a withe around his axe. This was a difference in detail between the style of implement of the two countries. It was not because the European man did not know to make a groove and put a withe around it, for his mining tools were made in that way; nor, on the other hand, was it because the American could not drill a hole in stone, for he drilled as much and as finely as did the European.

There were other differences of detail. The pottery of America may be larger and more finely made, but in both Hemispheres the processes were practically the same. There is as much difference to-day in pottery making establishments in adjoining shires or counties in either of the two countries, as there is between the countries themselves.

Ornaments of stone and shell may be different in the two countries, but they are at last but ornaments, and as such have their local fashion.

There may be other differences with other implements and industries, but they are of degree rather than of kind. I may fairly stand by the proposition that there will be found as great differences between the primitive or prehistoric industries, for example between those of the Atlantic and Pacific Coasts of America, between those of the United States and Mexico and Central America, as will be found between those of Europe and America; so, also, will there be as much difference between the industries and implements of the dolmen people and the lake dwellers, or between those in the Scandinavian and the Iberian Peninsulas.

Basketry may serve as an illustration. We have just received, at the U. S. National Museum, a fine collection of primitive basketry from California, representa-

tive of the Pacific Slope. It differs greatly from the prehistoric basketry of either Europe or the Atlantic Slope in that it is much finer and better made, but the stitches and plaiting are on the same general system and done in the same general style. While the difference is marked it is at last one of detail and may be explained. A theory by which the present difference may be explained is that the art became perfected in California, not alone since the migrations from Europe, but since the establishment of the Indians on the Pacific Coast, while it has died out on the Atlantic Coast.

Bronze found no lodgment in North America. A good explanation is that the migration from Europe by which America was peopled, took place prior to the advent of the bronze there. There might have been more than one migration to America; one during the Paleolithic and a later one during the Neolithic period; but it seems not to have been repeated after bronze became known in that country.

The principles which underlie this argument of similarity of industries as proving migration or communication or contact, do not depend alone upon the similarity of the objects, but also upon the difficulty of manufacture and performance, the intricacy of the operation required, the skill of the workmen; and to these may be added the closeness of resemblance, the similarity of detail, and the number of repetitions. A single specimen, or a few specimens having only an insignificant or uncertain similarity, might be of no avail in establishing the proposition of migration or communication of peoples between the countries; while, as the resemblances are increased, and an increase in the intricacies of manufacture, in the difficulties of performance, in the skill required to make or operate the tool or machine, would very materially increase the testimony in favor of migration, and add weight to the evidence.

The theory that the similarities of human thought account for the similarities of human culture in widely separated countries and among peoples without prior communication, savors of gross materialism, and is to be rejected as erroneous. That there are similarities of human thought is to be admitted, but if these control man in his progress and compel his passage in a materialistic or predestined path, they rob him of his free will and make him only a creature of circumstances. The best illustration I can suggest proving the error of this theory, is the action of human thought as manifested in human speech or writing. We may assume that human emotions, feelings, desires and wishes are much the same among all people. Each human being loves weeps, pities, hates, envies, etc., much the, same as does every other. If they were to describe their feelings, one might expect to find it done in much the same language. Yet we know, for a fact, that this is not so. If so done, it is charged as plagiarism. Of the thousands who have thus written, scarcely a 'baker's dozen' have ever been thus charged. The reason most apparent is that with all the similarity of human emotions, feelings, desires and wishes, the expressions thereof are so different when emanating from different authors that none lay themselves open to such a charge.

I am opposed to the theory advanced by certain anthropologists, that the similarity of human thought is a satisfactory explanation of the similarity of human culture in the case of widely separated peoples. That there is similarity of human thought between peoples, however widely separated, is conceded; but this theory is employed to account for the similarities of human culture otherwise than by migration, contact or communication. I prefer to account for similarity of culture (especially industrial) among widely separated peoples by migra-

tion, or by communication or contact. If we accept the doctrine of the unity of the human species, we are forced to admit contact between peoples of different countries as accounting for the differences in their cultures rather than to account for it by the similarity of their respective thoughts. The race could not have been perpetuated, the new peoples could not have been born, the different countries would never have been peopled, whether separated or not, except on the theory of migration and communication or contact. It is only by contact that subsequent generations could have appeared, and only by migration that they could have become separated. If the spread of culture by migration is denied, the spread of the race must also be denied. The two things, similarity of race and of culture, stand on the same foundation. This foundation is migration, communication, contact.

Monuments, Burial Mounds and Tumuli.

Nothing has yet been said as to the monuments or art of prehistoric man. The art is sufficiently explained in my work on 'Prehistoric Art'; published in the report of the U. S. National Museum for 1896, pp. 325–664, with 74 plates and 325 text figures, and I need not dwell further on it.

The monuments of prehistoric times are curious and strange. Whatever country we may consider, they excite our wonder and admiration. The ingenuity, invention, thought and general *savoir faire* of the prehistoric man as shown in his industries, and the taste and genius shown in his art, all pale before his ability as an architect and builder.

The principal monuments made by prehistoric man in most countries and times seems to have been funereal. The paleolithic man made no monuments, and it is doubtful if he habitually buried his dead. But the neolithic man expended his energies and powers in the erection of tombs and monuments intended to protect, and possibly to commemorate, his dead.

Dolmens were chambers of stone in which the dead bodies were placed. In Europe mounds were frequently, and in America were always erected over such burials, and these stand as testimonials of the affectionate regard with which the barbarian of prehistoric, whether in Europe or America, regarded his dead.

Although these monuments may not be the same in the details of their construction in both countries, they are all founded on the same principle of regard for the dead. This remark applies equally to Europe as to America. The burial tumuli and dolmens of Lozére and Morbihan in France do not contain a greater number of bodies than those of the Turner, or the Hopewell group in Ohio; while for size, extent and complicated design and perfection of execution, those we are to see during this session at Newark, Circleville and in the Scioto Valley will equal any throughout Europe.

The military monuments, fortresses, embankments, squares, circles and breastworks of the two countries tell the same story. They were built in both countries, sometimes of stone and again of earth, and show in every quarter an amount of engineering skill. The parallel lines at Marietta and Piketon, the circles and octagons on the State camp-ground at Newark, in the Scioto Valley, and at Portsmouth, Kentucky, have their counterparts in the extensive earthworks of protective ditch and embankment of Camp Peu-Richard at Saintes (Charente); while the fortresses and camps of stone or earth of forts Ancient or Hill, or opposite Bournemouth, are but the complements of Camp de la Malle (Alps Maritimes) or the great Gaulish fortress of Uxellodenum on the Dordogne.

Other monuments in Europe occupy a

relatively restricted area, the menhirs, isolated standing stones, cromlechs, alignments, standing stones erected in circles, and squares or parallels. No corresponding monuments have been found in America.

I must conclude. My time and your patience are about exhausted. I recognize my shortcomings and apologize for them; but who can accomplish in one address the history of the first appearance of man on earth and, describing the discoveries of the century, reduce them to the limitations and nomenclature of a new science? The difficulty is increased when we consider that the want of harmony on these subjects is as great among our own scientists as it is between them and their foreign brethren.

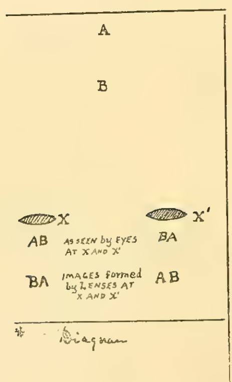
THOMAS WILSON.

U. S. NATIONAL MUSEUM.

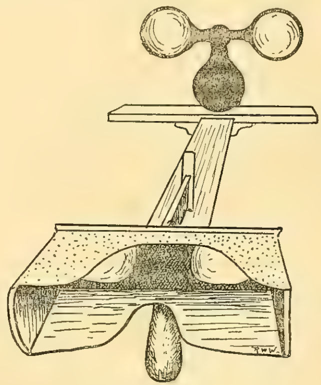
A NEW FORM OF PSEUDOSCOPE.

IN the Wheatstone pseudoscope the left eye is made to see an object from the point of view of the right eye and *vice versa*, by means of a system of mirrors. I have recently devised a method of converting an ordinary stereoscope into a pseudoscope, which can be used to view near or distant objects, and which yields results far superior to the old form of instrument.

If two small lenses of equal focus (5 or 6 cms. is about right) are mounted side by side, they will form two inverted images in space lying in the same plane, of any object towards which they are directed. These images are not only inverted but have left and right interchanged, and when fused



* Diagram



A NEW Pseudoscope -
Figure -

either by viewing them with the axes of the eyes parallel, or by means of a stereoscope will give rise to pseudoscopic vision, as will be readily understood by reference to the diagram.

Let A and B be two points in space, B being in front of A. An eye at X will see B to the right of A, and an eye at X' will see B to the left of A, and the fusion of these two images produces stereoscopic vision, B appearing nearer than A. Suppose now that X and X' represent the two

lenses. The images which they will form in space will be reversed, that is the lens X will give an image* in which B will be to the left of A, or just the opposite of the appearance presented when the eye is at X. It is apparent that the images BA and AB formed by the lenses are identical with what would be seen by eyes at X and X', provided A were in front of B, consequently the fusion of these two images makes A appear nearer than B.

It is possible for one who has trained the eyes to view stereoscopic photographs without the aid of the stereoscope, to bring the two images together in the same manner, but most persons will require the assistance of the prisms. My instrument consists simply of a double magnifying glass (consisting of two lenses mounted in rubber frames) mounted on the picture holder of an ordinary stereoscope, as shown in the figure.

A neater device would be two small lenses cut square and mounted in a frame arranged to slide along the bar of the stereoscope, or better still the instrument could be given the opera-glass form.

The best objects to view with the instrument are small decorated bowls either right side up or bottom up, and such simple objects. They appear to the best advantage when viewed from above.

The image appears reduced in size but exceedingly brilliant and sharp and the pseudoscopic effect is sometimes perfectly startling.

If the experiment is tried in the manner which I have described with a double magnifying glass, it is important to see that the two lenses have the same focal length, which is often not the case.

R. W. WOOD.

MADISON, Wis.

* I have drawn the images formed by the lens erect for the sake of simplicity. They are, of course, inverted in reality.

THE SUBDIVISION OF GENERA.

IN view of the almost universal acceptance of the doctrine of evolution by naturalists, most of the old discussions regarding the 'generic value of characters' read much like those about the nature of phlogiston. If we must admit that even species are largely conventions, holding good only so long as our observation of them is limited in respect to time, areas and conditions, the larger subdivisions—genera, orders, etc.—must necessarily and *a fortiori* be regarded in the same light, as groups comprising forms agreeing in a large number of important and striking characters, and which it is, therefore, convenient to regard from a common standpoint for the purposes of study; as forms probably derived from a common ancestor at a relatively not very remote time. If then admittedly genera are not established by nature but are man-made, it would seem desirable to adopt with reference to them the policy most conducive to a ready and comprehensive view of their relations to other groups of forms, and to facility of study. The latter consideration should weigh heavily, in view of the steadily increasing interest and instruction in natural science. It is certain that the study of the latter is greatly hindered by the multiplication of names, both generic and specific, and by the unnecessary substitution of terms of Greek and Latin derivation for well-understood English words of definite meaning.

On the other hand, the detailed study of any group by specialists necessarily results in the discovery of new common characters within certain closely-related groups of forms, by which they may be conveniently subdivided for comparative study. Of course, there can be no question of the importance of such study of the minute characters, which leads us more and more closely to the immediate effects of environment. The only question is how best to

make the results of such studies available to the general student, without at the same time compelling him to become a specialist himself (at least for the time being), at the cost of time and mental strain that can be more profitably otherwise employed. Excessive, and especially premature specialization, *pre*ceding instead of *suc*ceeding the establishment of a broad basis of general knowledge, is recognized as one of the most serious evils of our present system of scientific training and investigation. The specialist is becoming less and less capable of fruitfully correlating his results with the general facts and principles of the cognate branches of science, and the overweening self-esteem born of narrow training and ignorance of wider fields, is too often apparent both in writings and personal intercourse. At the same time, the coining of unnecessary new terms and names, more especially indulged in by this class of investigators, renders even their good work difficultly available to students outside of their specialties. Among the most aggravated and aggravating difficulties so imposed is the introduction of new generic names upon the basis of discrimina alleged to be cogently 'generic'; a tendency fostered by the ambition to have one's name forever associated with such new names.

Now if, as evolutionists must hold, genera, and orders as well, are essentially group arrangements made by man for the purpose of subsuming related forms under a general point of view for more ready and fruitful study, it would seem that the more comprehensive such points of view can be made, the better the main purpose will be subserved. So far from being closely *limited*, the definition of the genus should be as *wide* as possible; so that for the purposes of the general student, its members would be called by the most comprehensive name compatible with the objects of general study.* The specialist, on the other hand, may make use of the wider designation so far only as it may be useful for his discussion, while employing for the minor subdivisions required by his new points of view, such 'subgeneric' or 'sectional' designations as have heretofore stood for ill-defined genera.

It seems to the writer that the generalized point of view could thus be kept within convenient reach of the general student, while the subgeneric designations would afford the specialist ample facilities for discussion with his fellow-workers. Anyone desiring to specialize in a particular line would readily familiarize himself with the specialist's subgeneric or sectional terms. It would seem that in this way, the interests of both classes of students, as well as of science at large, would be effectually safeguarded and fostered, and the participation of a wider constituency in science study essentially facilitated.

E. W. HILGARD.

THE CARD INDEX OF EXPERIMENT STATION PUBLICATIONS.

IN view of the recent discussions regarding card indexes of scientific literature many of the readers of SCIENCE may be in-

* A striking example of the opposite principle appears in Bulletin 18 of the Division of Agrostology, 'Synopsis of the genus *Sitanion*.' In the introduction, Scribner, in giving the characters upon which the genus is based as distinct from *Elymus*, remarks that they '*justify* the separation of these species as a distinct genus,' although "to be sure there are species so closely connecting *Elymus* with *Sitanion* that it is difficult to say to which genus they ought to be referred." These intermediate forms "indicate their close relationship, but this fact does not afford sufficient reason for *uniting* them. * * *"

Here it is evident that the view held is that genera should be as *closely limited* as possible; regardless of the fact that the obvious close resemblance of these plants will put every student, not a specialist, to the trouble of eliminating all the species of the well-known genus *Elymus* before considering the unfamiliar *Sitanion;* which as a subgenus of the former would have just the standing its slight structural differences seem to justify.

terested to know something about such an index which is regularly issued by the Office of Experiment Stations of the United States Department of Agriculture. The general plan of the index may be briefly outlined as follows :

The subjects with which agricultural science deals have been grouped under thirteen general topics. These topics have been divided and subdivided only so far as seemed necessary to facilitate references to the individual entries of the index. As the work of the stations reaches out in many directions into the domain of pure as distinguished from applied science, a section of the index has been set apart for entries relating to the general principles of the various sciences which lie at the foundation of experimental investigations in agriculture. This affords a wide opportunity for the extension of the index by individual students for their own special purposes.

The index is printed on cards of a standard library size. The divisions and subdivisions are arranged on a decimal system and are plainly indicated by the use of division cards of different colors.

Each index card contains the title of an article, the name of its author, a reference to the publication in which it appeared and to the Experiment Station Record, and a condensed statement of its contents. At the upper right-hand corner of the card is a number indicating under what head the card should be placed in the index. The order in which the cards are printed is indicated in the lower left-hand corner.

A key to the index, containing the system of classification, is sent with the first installment of cards.

While planned so that any scientific and other literature relating to agriculture might be included, the index has thus far been confined to the publications of the agricultural experiment stations in this country.

One copy of the index is sent without charge to each of the agricultural colleges and experiment stations and the State boards of agriculture. Besides this free distribution, the Office is prepared, under the authority of the law, to furnish a limited number of sets of the index at a price only sufficient to cover additional cost of printing. This is estimated at $2 per thousand cards. For the division cards an additional charge of $1.25 is made.

The Office has now issued 18,000 index cards and a set of division cards. Three hundred sets of this index are printed.

Experience has shown many difficulties in making such an index thoroughly satisfactory. Where publications are issued as irregularly as those of the experiment stations necessarily are, the systematic indexing of their contents inevitably prevents the bringing of the index closely up to date. To keep the number of cards within reasonable limits and satisfy the needs and demands of specialists in different subjects is practically out of the question, especially in such subjects as entomology, where many different topics are often treated in a single article and the important article consists of a series of short notes.

The chief value of such an index seems to lie in the fact that it enables the user to get together rapidly a considerable amount of information on many of the topics included in it. Thus the student, teacher or lecturer is helped in his work in various ways. But when it is desired to make an exhaustive study of any subject the card index is likely to be of comparatively little use unless it could be made very extensive, in which case few libraries would care to give it room.

For the thorough examination of the literature of any scientific subject, I believe that no work of reference can compare with a well-made abstract journal having a detailed subject and author index. Such an index the Office of Experiment Stations at-

tempts to make for the Experiment Station Record. The ninth volume of the Record contains 1,100 pages of text, of which 770 pages are taken for abstracts of publications originally occupying 56,569 pages. In addition to this, the volume contains 2,471 titles of articles, with brief abstracts in some cases. The index of names for this volume fills 15 pages printed in nonpareil type in three columns; the index of subjects fill 80 pages printed in the same type in two columns.

Now that ten volumes of the Record have been completed, the question of making a general index to cover them has been raised. If such an index can be provided for at intervals of ten years it is believed that this and the annual indexes with a set of the Record will constitute an instrument for ready reference to the literature of agricultural science much more convenient and effective for the uses of the specialist than any card index can be.

A. C. True.

Washington, D. C., October 23, 1899.

SCIENTIFIC BOOKS.

West Virginia Geological Survey. Volume I. By I. C. White, State Geologist, Morgantown, W. Va. 1899. 8vo. 392 pp. Map.

Dr. White was commissioned as State Geologist in 1897 and began work in the autumn of that year. This first volume gives only a portion of the material accumulated prior to the close of 1898, as the appropriation for printing was very small. Political complications during the session of 1899 hindered legislation and the survey work will remain suspended until after the next session of the Legislature.

At the time this survey was undertaken, the all-absorbing matter of economic interest was that of oil and gas, with which Part IV. of the report, occupying 270 pages, deals. The historical sketch of discovery, methods and utilization of oil and gas in the State is followed by a discussion of the geology of those products, treating of method of occurrence; quantity to the acre; aids in location; anticlinal theory; relation of oil and gas to structure; and other topics full of interest, viewed from the standpoint either of pure science or economics. The anticlinal or structural theory of the occurrence of oil and gas, presented by Dr. White many years ago, is elaborated here in the light of developments made in the Ohio and West Virginia fields. Though leading to slight modification of statements made when the theory was rather suggested than asserted, these severe experimental tests have rendered necessary no material changes, but on the contrary have shown that the theory was but the expression of a law. One cannot give a synopsis of the discussion for that is itself a model of condensation. It possesses much interest not only for the student of economic geology, but also for those geologists who find little that is attractive in matters relating to economic interests.

The general section through which wells have been drilled is described. It extends from the Permo-Carboniferous to the Corniferous limestone, a total of 7,200 feet, a thickness contrasting notably with that in south central Pennsylvania, where the upper Devonian alone (the Chemung and the Catskill of Vanuxem) is as great. The records of 104 wells drilled in different parts of the State are discussed in detail, compared with each other and with localities where the rocks are exposed. These wells are from 1,000 to more than 4,000 feet deep. The labor involved in working up the bald records into intelligible sections, of identifying the several coal beds and the subordinate sands, can hardly be conceived by those who have not done such work; the more so, since necessarily the published records form but a small part of those studied in order make the comparisons conclusive. The writer in the course of a study, still in progress, tabulated all these records given by Dr. White to compare them with results obtained by other observers in West Virginia, Ohio and Pennsylvania. Out of all the many points at which the several sets of observations came together, only two were found where it seemed impossible to accept Dr. White's conclusions—and in one of these Dr. White proved to be right.

This volume is a contribution so important that one cannot fail to regret the neglect of the

Legislature which has prevented publication of the volume on coal. That interest, owing to the sudden expansion of iron manufacture, is now paramount, and the state is losing enormously by this failure to publish the material accumulated by Dr. White in extended reconnaissances during the last ten years. To those engaged in investigating the serious problems presented by the Carboniferous, the inaccessibility of this material is a misfortune.

The map shows the oil fields and productive areas of the several coal series. The limits of the Pittsburg, as determined by borings, differ from the Rogers lines as much for West Virginia as for Ohio. The geographical conditions during the formation of that bed were evidently very unlike those suggested by the older geologists.

The abundance of typographical errors is evidence that the author had no opportunity to correct the proofs, and reminds the writer of his own experience with the West Virginia State Printer almost thirty years ago, when Mr. F. B. Meek and he were made chargeable with statements which afforded some annoyance to them and much amusement to their acquaintances.

JOHN J. STEVENSON.

Introduction à la géométrie différentielle suivant la méthode de H. GRASSMAN. Par C. Burali-Forti, professeur à l'Académie militaire de Turin. Paris, Gauthier-Villars. 1897. 8vo. Pp. xi + 165.

This volume contains a brief exposition of the geometrical calculus and some of its applications to elementary differential geometry.

The analytical geometry of Descartes (1637), operates on numbers which have an indirect relation with the geometrical elements which they represent. Leibnitz* in 1679 recognized the advantages of a geometrical calculus operating directly on geometrical elements, but the operation suggested by Leibnitz does not possess the ordinary properties of algebraic operations. The idea, however, was fruitful, and in 1797 Caspar Wessel† gave an analytical representation of direction which contains Argand's (1806) geometrical interpretation of complex numbers and several of the operations introduced by Hamilton (1843–1854) in his method of quaternions. Later the barycentric calculus (1827–1842) of Möbius and the method of equipollences (1832–1854) of Bellavitis brought forward two independent methods of geometric calculus which their authors applied to various questions of geometry and mechanics. In 1843 Hamilton published his first essay on quaternions ; the complete development of this theory in 1854 gives a complete geometrical calculus which finds at present its most extensive applications in mathematical physics. The works of Hamilton were preceded by the Ausdehnungslehre (1844), of H. Grassmann which, in the power and simplicity of its operations, surpasses all other known forms of geometrical calculus. The method of exposition adopted by Grassmann is exceedingly abstract and this fact has stood stubbornly in the way of the general adoption of the Ausdehnungslehre to such an extent that we use to-day the bar
tric calculus, the theory of equipollences, quaternions, or the Cartesian geometry, for the resolution of geometric questions which are capable of much more simple resolution by the methods of Grassmann. These classic objections to Grassmann's exposition have been met recently by Peano* who has given concrete geometric interpretations to the forms and operations of the Ausdehnungslehre. There is a splendid account of the importance of this discipline in geometry, mechanics and physics to be found in the historical memoir of Schlegel.†

M. Burali Forti gives the elements of Grassmann's calculus as reconstructed by Peano. The latter took the idea of a tetrahedron as his starting point and defined the product of two and three points ; he then defined the products of these elements by numbers and finally gave definitions of the sums of these products. The theory of forms of the first order gives the barycentric calculus and that of vectors ; the geometric forms of the second order represent straight lines, orientations, and systems of forces

* Leibnitz, *Math. Schriften*, II., V., Berlin, 1849.

† Caspar Wessel, Om Directionens analytiske Betegning, March 10, 1797 ; published by the Denmark Academy of Sciences, Copenhagen, 1897.

* Peano, Calcolo geometrico, Turin, 1888.

† Schlegel, Die Grassmann'sche Ausdehnungslehre, *Zeitschrift für Math. und Physik*, 1896.

applied to rigid bodies; the forms of the third order represent planes and the plane at infinity. Among the operations, the progressive and regressive products give the geometric operations of projecting and cutting; the inner product gives the orthogonal projections and the elements which we designate in mechanics by the terms moment, work, *et cetera.*

In ordinary differential geometry simple properties most frequently yield themselves only after very complicated calculations. This complication is due in general to the use of coördinates; with these coördinates algebraic transformations are made on numbers in order to obtain certain formulæ, namely, invariants, which are susceptible of geometric interpretations. On the other hand the geometrical calculus makes no use whatever of coördinates; it operates directly on the geometric elements; each formula which it produces is an invariant, capable of a simple geometric interpretation and leading directly to the graphic representation of the elements considered. Burali-Forti's work, though by no means a pioneer in the application of Grassmann's theories to differential geometry (note for example the memoirs of the younger Grassmann in the theory of curves and surfaces), shows the elegant power and simplicity of the geometrical calculus in elementary differential geometry and points the student to a vast field of transformations and researches in higher geometry.

The work is designed after the following plan which exhibits the skeleton of its contents:

I. The geometric forms.—1° Definitions and rules of calculus:—tetrahedron, geometric forms, equality of forms, points, segments, triangles, sum and product by a number, progressive product; 2° Vectors and their products:—vectors, bivectors, trivectors, rotation, operation index; 3° Reduction of forms:—forms of the first order, forms of the second order, forms of the third order, projective elements, identity between forms of the first order; 4° Regressive products:—forms of the second and third orders, forms of the third order, general properties of products, duality, regressive products in a projective plane; 5° Coördinates.

II. Variable forms.—1° Derivatives:—definitions, limit of a form, limit of a projective element, derivatives, mean forms, Taylor's formula, continuous forms; 2° Lines and envelopes:—lines and envelopes of straight lines on a projective plane, space curves and envelopes of planes; 3° Ruled surfaces:—ruled surfaces in general, skew ruled surfaces, developable surfaces; 4° Frenet's formulæ:—arcs, curvature and radius of curvature, torsion and radius of torsion, formulæ of Frenet, spherical indicatrix and angle of contingence.

III. Application.—1° Helix; 2° Surfaces ruled relative to a curve—polar surface, rectifying surface, surface of principal normals, surface of binormals, skew ruled surfaces whose line of striction is given, developable ruled surface described by a straight line whose position is fixed with regard to the tetrahedron PTNB; 3° Orthogonal trajectories:—orthogonal trajectories of the generatrices of a ruled surface, evolutes, involutes, orthogonal trajectories of planes of an envelope; 4° Curves of Bertrand.

NOTES.—1° Forms which are functions of two or more variables; 2° Tangent plane; 3° Differential parameter of first order; 4° Curvilinear coördinates. E. O. LOVETT.

PRINCETON, NEW JERSEY.

Chemical Experiments. By JOHN F. WOODHULL, Professor of Physical Science, Teachers College, Columbia University, and M. B. VAN ARSDALE, Instructor in Physical Science in Horace Mann School and Assistant in Teachers College. New York, Henry Holt & Co. 1899. Pp. 136. Price, 50 cents.

This book gives a series of very elementary experiments dealing chiefly with the elements oxygen, hydrogen, chlorine, sulphur, nitrogen and carbon. The apparatus recommended for the experiments is simple, and in several cases, quite ingenious. For pupils of a certain grade the book will doubtless prove useful, but the introduction of a few more quantitative experiments designed to illustrate fundamental principles seems desirable.

A Laboratory Outline of General Chemistry. By ALEXANDER SMITH. Chicago, Kent Chemical Laboratory of the University of Chicago. 1899. Pp. xii+90.

The work before us represents a very dis-

tinct advance in the teaching of General Chemistry. Dr. Smith appears to recognize more clearly than most teachers have done that chemical experiments for beginners should not be selected merely or chiefly to give a knowledge of the striking superficial properties of a few substances, but that they should be so devised that the student may acquire a direct experimental knowledge of those facts on which the real science of chemistry rests. For this reason the book contains an unusual number of carefully selected quantitative experiments. The book is notable also because of its introduction of experiments to illustrate ionization and the phenomena on which the modern theory of solutions is based. The directions are of such a nature, too, as are suited to develop independent thought and self-reliance. The student who thoroughly masters the course laid down will have made a good beginning toward an understanding of chemistry and of how chemists work. W. A. NOYES.

GENERAL.

La Théorie de Maxwell et les Oscillations Hertziennes, by H. Poincaré (Paris, George, Carré et C. Naud, 1899), is a popular exposition of the mathematical treatise on the subject by the same author, which was reviewed in SCIENCE for January, 1895. It is one of the series of popular treatises on scientific subjects published under the general name 'Scientia.' It is very attractive both in form and in substance and will furnish much interesting reading to those who have neither time nor inclination to study the mathematical treatise. M. I. P.

THE excellent 'Manual of Bacteriology' of Muir and Ritchie (The Macmillan Company, 1899), already reviewed in these columns, has in the second edition been revised, brought up to date and somewhat enlarged. It is, as was the first edition, a bacteriology for medical folk. About one-quarter of its pages are concerned with general technique; the remainder with excellent, short and clear, but fairly comprehensive descriptions of pathogenic micro-organisms. The exposition of that difficult and dangerous theme, immunity, is admirable. The bibliographic suggestions are good, the historical glimpses illuminating. Altogether, the book is of such evenly sustained excellence throughout, that among a small host of competitors of similar scope in various languages, it easily holds the leading place. T. M. P.

THE authorities of the Royal College of Surgeons in England have made arrangements for the compilation of a descriptive catalogue of the vertebrate brains in the Museum. Dr. G. Elliott Smith, of St. John's College, Cambridge, will undertake the work.

BOOKS RECEIVED.

The Elements of Alternating Currents. W. S. FRANKLIN and R. B. WILLIAMSON. New York and London, The Macmillan Company. 1899. Pp. 212.

Pulmonary Tuberculosis; Its Modern Prophylaxis and the Treatment in Special Institutions and at Home. S. A. KNOPF. Philadelphia, P. Blakiston's Son & Co. 1899. Pp. 343.

The Story of the Fishes. JAMES NEWTON BASKETT. New York, D. Appleton & Co. 1899. Pp. xxii + 297.

About the Weather. MARK W. HARRINGTON. New York, D. Appleton & Co. 1899. Pp. xx + 246.

Determination of Radicles in Carbon Compounds. H. MEYER. Authorized translation by J. BISHOP TINGLE. New York, John Wiley & Sons; London, Chapman and Hall, Ltd. 1899. Pp. iv + 133. $1.00.

SCIENTIFIC JOURNALS AND ARTICLES.

IN *The American Naturalist* for October the leading article is an interesting paper of 'Notes on European Museums,' by O. C. Farrington, giving many interesting details of methods of installation. An important paper by O. P. Hay is 'On some Changes in the Names, Generic and Specific, of certain Fossil Fishes,' noting a number of names which must be considered as synonyms and replaced by others which are suggested. The 'Utility of Phosphorescence in Deep-Sea Animals' is discussed by C. C. Nutting, and C. P. Sigerfoos describes 'A New Hydroid from Long Island Sound' under the name of *Stylactis hooperi*. The habits of 'A Balloon-Making Fly,' an *Empis*, is described by J. M. Aldrich and L. A. Turley, while the question 'Have we more than One Species of *Blissus* in North America' is answered in the negative by F. M. Webster. The fourth part of 'Synopsis of North-American Invertebrates'

is by J. S. Kingsley and is devoted to the 'Astacoid and Thalassinoid Crustacea.' The balance of the number is devoted to Reviews and News. The very useful list of appointments to various scientific positions here and abroad is unusually full.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON 310TH MEETING, SATURDAY, OCTOBER 21ST.

F. A. LUCAS made some remarks on the flightless Harris' Cormorant, stating that the keel of the sternum was lacking save the anterior point to which the furcula was attached, that the pelvic girdle was very robust, though not quite equal in this respect to the larger Pallas' cormorant. The nearest relative was *Phalacrocorax penicillatus.*

O. P. Hay presented 'A Census of North American Fossil Vertebrates,' giving the number of genera and species in each order. Special attention was called to the great number of selachians represented in the Sub-Carboniferous and their apparent scarcity in the succeeding formations.

V. K. Chesnut presented some 'Notes on a Preliminary Catalogue of Plants Poisonous to Stock,' saying that some plants were not in themselves poisonous but acted by clogging the intestines, perforating and inflaming the tissues of the eyes, nose or intestinal tract, or by the evolution of gases which distended the stomach and intestines to such an extent that the lungs and heart could not properly perform their work. Corn smut was deleterious from the expansion of the dry powdery spores, while some molds whose spores will germinate and grow in the body apparently produce a poisonous compound concomitantly with their growth. It was noted that some plants vary greatly in virulence at different seasons, and that others which were useful in small quantities were injurious when fed continuously.

H. J. Webber spoke on 'Polyembryony in Orange Hybrids,' calling attention to the curious results obtained in hybridizing the Trifoliate orange (*Citrus trifoliata*) with the Sweet orange (*Citrus aurantium*). In a number of instances two totally different seedlings were produced from the same hybrid seed. Of the numerous embryos produced in a single orange seed, one apparently develops normally from the fecundated egg cell and the other from certain cells of the nucellus near the upper part of the embryo sac, which become specialized, divide rapidly, and pushing out into the embryo sac form embryos. Usually several of these adventive embryos are developed in each seed. In hybridization the embryo developed from the egg cell is naturally the only one which shows any influence of the male parent. The adventive embryos which spring from the nucellar tissue of the mother parent could not be expected to show any effect of the cross. In crosses of the Sweet orange with pollen of the Trifoliate orange several seeds have developed more than one seedling, of which one has trifoliolate leaves similar to the pollen parent and the other, or others, unifoliolate leaves like the sweet orange mother parent. In such cases the speaker thought there can be no doubt that the trifoliolate seedling develops from the egg cell and is the only one affected by the hybridization, while the unifoliolate seedlings develop from adventive embryos and are not affected by the cross.

Albert F. Woods gave some 'Additional Notes on Spot Disease of Carnations,' stating that as the result of long experimentation he was able to positively confirm his former statements that the disease was not produced by bacteria, but was caused by the punctures of Aphids and Thrips. The curious device by which the slender bill of the aphis was enabled to be inserted between the plant cells was also described.

O. F. COOK,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY OF THE NEW YORK ACADEMY OF SCIENCES.

THE regular meeting of the Section was held on October 23d. Dr. E. L. Thorndike reported some experiments on mental fatigue. The general plan of this investigation has already been described in SCIENCE of May 19th. The experiments reported confirm the earlier conclusion that there is no decrease in amount, speed or accuracy of work in the evenings of days of hard mental work over mornings or in

periods immediately following prolonged mental work over periods preceding it.

Dr. Livingston Farrand read a paper on 'Basketry Designs of the Salish Indians.' The paper was a contribution to the solution of the problem of the evolution of decorative art and particularly of the question of development of geometric patterns from realistic portrayals of natural objects. Attention was confined to the basketry designs of the Salish Indians of British Columbia and western Washington, which exhibit certain peculiarities marking them off rather sharply from the designs used by neighboring stocks. It was shown that while the adjacent tribes in the Northwest make use almost exclusively of animal designs, and their conventionalism is of a unique nature and not geometric, the tendency of the Salish decorations, on the other hand, is entirely in the direction of extreme geometric conventionalization and the use of animal motives is not predominant. The questions of variants and of convergent evolution in designs were discussed, and the points made were illustrated by the exhibition of a large number of designs taken from the baskets collected by the Jesup North Pacific Expedition from the region under discussion.

C. H. Judd read a paper on 'Movement and Consciousness.' Reference was made to the recent psychological discussions which have emphasized the importance of movement and motor nervous processes as conditions of consciousness. It was pointed out that just as psychology must look for the conditions of sensation elements in non-psychical processes, so a careful analysis of the facts of perception force us to look for the represented factors and for the synthetic activities in non-psychical conditions. In support of this position examples were cited in which the representative factors were not capable of conscious revival even with concentrated attention, and it was shown that synthetic activities become progressively less conscious the more complete and immediate the process of perception becomes. Finally, the attempt was made to discover in the facts of movement and in the nervous processes which follow the reception of sensory stimulations, the conditions of perceptual synthesis and the conditions which make possible present effects of past experience without complete or even partial revival of any sensory factors, either as revived sensations or as repeated sensory stimulations in the nervous system.

CHARLES H. JUDD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

RECENT WORK ON COCCIDÆ.

THE writer was away from his office and without access to current literature for most of the summer just passed, and only recently has seen in SCIENCE for July 21st (pp. 86–88), the reply of Professor Cockerell to the article entitled 'Sources of Error in Recent Work on *Coccidæ*' (SCIENCE, June 16, 1899, pp. 835–837). The article last cited was written with no other intent than to point out, with the hope of benefiting the future literature on the subject, certain sources of error which were being rather emphasized by some of the more recent work on scale insects. To avoid personal features, the enumeration of examples was reduced to a minimum and the chief offenders were not pointedly indicated. That some check of this sort was needed is evident enough to any one familiar with the literature, and is further shown by the writer's having received, since the publication of the article cited, letters thanking him for his action from several of the leading entomologists of this country and oral thanks from a good many others, not to mention such editorial approval as that in the *American Naturalist* for September, 1899.

Professor Cockerell's reply serves two very useful purposes. First, it does what the writer, through a perhaps ill-advised sense of courtesy, failed to do, namely, indicates the real and chief offender, who now comes to the front and courageously announces, 'I am the man!' In the second place, it enables him to point out definitely the character of work which had previously been referred to in very general terms out of consideration for the persons concerned whose work in the main it was not wished to disparage.

The opening remarks of Professor Cockerell, relative to his eight years experience in *Coccidæ*, are rather regrettable in view of some of the

results they have yielded; in fact, this whole paragraph reminds one more of the efforts of an attorney with a bad case to indulge in disparagement of the opponent rather than the introduction of evidence. In discussing at length, as Professor Cockerell does, the difficulty in determining what are good specific characters, very safe ground for dilation is found, but unfortunately this discussion has little bearing on the criticisms in the original article which applied for the most part to the use of trivial characters, or such as have no relation whatever to the insect itself, but rather to its coverings and general surroundings.

Coming now to the example of the kind of work mentioned, and the complaint is made that the writer has generalized on very insufficient grounds, the synonyms for which Professor Cockerell is responsible of a single species will be considered, and these furnish ample material to illustrate the faults alluded to. The species taken to serve this purpose is *Aspidiotus lataniæ* Sign., hitherto known in this country as *Aspidiotus cydoniæ* Comst.,* and variously by Professor Cockerell as the species last mentioned and also *convexus* Comst., *punicæ* Ckll., *greenii* Ckll., *lateralis* Ckll., and *crawii* Ckll. In other words, the synonyms of this species, as given by the writer in a recent number of the *Canadian Entomologist*, indicates that within the last three or four years Professor Cockerell has redescribed it not less than four times, besides indicating a fifth form by reference of material to '*convexus* Ckll. not Comst.'

If one examines the characters on which Professor Cockerell separated these supposed new species, now shown to be synonyms of *lataniæ*, their trivial, if not farcical, nature will be apparent.

* *Aspidiotus lataniæ* was described so briefly by Signoret that without an examination of the types it was altogether impossible to recognize the species in new material, and the failure to do so hitherto has every excuse. Fortunately, Mr. E. E. Green has recently been able to examine Signoret's types and has drawn up a careful and full description of the species, accompanied by an excellent figure of the last segment of the adult female insect. He points out the close resemblance of Signoret's species to Comstock's *cydoniæ*, and a comparison which I have made of Mr. Green's description and figure with type material of *cydoniæ* shows conclusively the identity of Comstock's species with Signoret's.

Before considering the status of these synonyms, it may be said in explanation that when Professor Cockerell was last in Washington he was invited by the writer to examine the type material representing them in the Department collection and to point out the characters upon which the species are based, the original descriptions having been very inadequate. He made such study and was unable to give structural characters of the insects themselves, but submitted a synoptical table based chiefly on the scale covering, as indicating his reasons for believing the species to be good. This table follows:

PROFESSOR COCKERELL'S TABLE.

1. Exuviæ dark brown or black............................ 2
   Exuviæ pale orange or brownish...................... 3
2. Lower Sonoran and tropical..........*cydoniæ* Comst.
   Upper Sonoran, on Salicaceæ and Melia
   convexus Ckll. not Comst.*
3. Exuviæ central or almost in the mature ♀ scale. 4
   Exuviæ lateral or sub-lateral in the mature ♀ scale (circumgenital glands few, groups of 2–5 only).. 5
4. Scale snow white; on *Punica*............*punicæ* Ckll.
   Scale greenish; mostly on Palms.......*greenii* Ckll.
5. Scale grayish brown; inner notch of median lobes absent, spines longer............*lateralis* Ckll.
   Scale rather larger, reddish gray; inner notch of median lobes distinct; spines shorter; processes of first interlobular interval short united *crawii* Ckll.

To appreciate this table it should be explained that the species concerned *lataniæ*, secretes in the case of the female a convex circular scale, and moults twice, the cast skins or exuviæ, and especially the second and larger one, ultimately becoming brownish in color and forming part of the central portion of the scale covering. The scale secretion proper is of white wax, but is as a rule discolored by a thin shale of bark carried up over it and by the dirt or mould which accumulates on the bark or on the scale itself. The exuviæ attach to the inner central portion of the scale and show through it as a brownish

*Some of the material thus referred actually represents an apparently undescribed species, but not that on the food plants mentioned.

spot. The approximately central position of the exuviæ is a generic character and applies to scores of species, but is often modified and quite naturally by the crowding of the scales or by irregularities of the surface on which the insect rests. The shade of brown of the exuviæ varies with the age of the scale, from pale orange at the start to different shades of brown, darkening more or less with time and exposure, and as influenced by conditions of moisture or dryness or different food plants, etc.

The question of locality is of little value, the species itself having a wide distribution and belonging to a group having an extensive range in point of latitude. The few structural characters noted, where they are not evidently based on the accidental effects of preparation and mounting, are included in the normal variation of typical specimens of Comstock's *cydoniæ*.

There remains, therefore, to be considered merely the extremely variable colorational features of the scale covering. Referring to the table, it will be seen that the supposed species are divided into two groups on the shade of color taken by the drying bit of cast skin or exuvia. The species with 'dark' exuviæ are separated on the ground of latitude, namely, those from north of a certain arbitrary line are *convexus*, and those from south of the same line are *cydoniæ*.

The group with lighter colored exuviæ (and be it remembered that with practically every lot of material the exuviæ of different specimens range widely in color) is again separated into two sections by the alleged central or noncentral position of the exuviæ. An examination of the type material indicates that the only possible basis for this is that in the scale or scales which happened to come under Professor Cockerell's eye, the exuviæ were pushed slightly to one side by conditions already noted. In this group, *punicæ* is differentiated by its possessing a snow white scale (which simply means that the scales examined happened to be free from extraneous matter), *greenii* is characterized by its having central exuviæ (sic !) and by a greenish coloration (which latter proves on examination of the material submitted by Professor Cockerell to be caused by a greenish mold or fungus which covers exteriorly a few of the scales. It must be confessed, however, that the writer had hitherto supposed that this species was given its name not from coloration, but in honor of Mr. E. E. Green !). The scale of *lateralis* differs in being grayish brown, a coloration derived from extraneous matter, and the species, as indicated in my former article, was described as a variety of Newsted's *diffinis* from immature specimens of *cydoniæ*. *Crawii* is separated because presenting a reddish gray coloration, which on examination is seen to come from the reddish bark of the plant carried up over the exterior of the scale as described in my former article.

Further comment is not needed, nor is it necessary to go beyond this single example, especially as this JOURNAL is not the most suitable place in which to undertake a revision of the entire group.

If all such careless and hasty work could be overlooked and ignored, little harm would result, but unfortunately these scale insects have many of them a considerable economic importance, and it is necessary to be able to determine them promptly and accurately. While it is possible for the care-free species-maker to sit down and, regardless of literature and type material, his own included, jauntily dash off, before breakfast perhaps, half a dozen new species and see them published the same week in the most accessible vehicle, it means unfortunately that someone else, if he be so favored as to get the type material and the description, has to spend hours perhaps with a microscope, dissecting needle, and drawing camera to determine finally that the insect described is an old and well-known species, or, in other words, what was five minutes' play for the heedless describer, causes the conscientious student, even under the most favorable conditions, several hours of real work.

One of the greatest evils complained of also is the complete disregard of proprieties and custom in the publishing of new species and new notes and facts regarding them in all sorts of out of the way and inappropriate places. 'The 20th Neotropical *Aspidiotus*,' published in a Chilian journal, may tickle the author's pride, but it adds very much to the difficulties of future students. Similarly new species and

varieties published as pamphlet brochures or as short papers in journals difficult or impossible of general access, as, for example, in such out-of-the-way places, from the standpoint of scientific literature, as Chile, Brazil, Jamaica, or Trinidad, are a positive detriment to science, because very few will ever be able to consult the original descriptions and very possibly the author himself often fails to receive a copy of them. This is all bad enough, but much worse is the use for publication of new species, or new facts and notes, of local daily or weekly journals of all sorts, such as *The Jamaica Post*, *Tri-Weekly Budget*, *Daily Gleaner*, *California Fruit Grower*, *Rio Grande Republican*, *Southwestern Farm and Orchard*, *Manhattan Kansas Industrialist*, *California State Board of Horticulture*, etc. In one number of the *California Fruit Grower*, for example, and none of the titles given are fanciful, no less than seven new species of scale insects are indicated, including *crawii* and *greenii*, noted above, and this as late as 1897.

This matter has been gone into perhaps already fully enough, and in fact the writer regrets the apparent necessity of continuing the discussion, hoping as he did that his first article would serve the needs of the case. If any 'running amuck' has been done, it is in the hasty publication of half-digested studies, as illustrated by the consideration of the single species given above.

C. L. MARLATT.

U. S. DEPARTMENT OF AGRICULTURE.

THE AMERICAN PHYSICAL SOCIETY.

THE first regular meeting of this latest comer in the brotherhood of societies was held at Columbia University, Saturday, October 28th. A preliminary meeting in June elected officers and decided some details.

It is proposed to hold four meetings annually, simultaneously with the American Mathematical Society, which also meets at Columbia University. It is hoped that the two societies will coöperate and benefit each other. At the same time the new society is pledged to coöperate with Section B of the American Association for the Advancement of Science.

On Saturday last the mathematicians adjourned to hear the opening address by the President, Professor H. A. Rowland, who handled the great questions which confront the physicist of to-day in a most interesting manner and elicited frequent applause.

After business discussion several papers were presented.

Professor Rowland described experiments which failed to demonstrate an 'ether-wind' or a movement of the ether with moving matter, which would be of extreme interest if found.

Professor Pupin showed a method of rectifying alternating currents by an electrolytic cell and battery.

Professor Webster gave a semi-popular illustration of the propagation of an electromagnetic wave in the ether, and deduced the formulæ. He also showed and explained a curve-tracing top.

The meeting was eminently encouraging. Some thirty or forty working physicists were gathered together, representing fifteen or sixteen leading universities and colleges, and all seemed agreed that the new society was needed and would be a success.

The next meeting will be held at Columbia University between Christmas and New Year.

The present officers are: H. A. Rowland, president; A. A. Michelson, vice-president; Ernest Merritt, secretary; W. Hallock, Treasurer.

W. H.

SCIENTIFIC NOTES AND NEWS.

BY the will of the late Judge Charles P. Daly, the American Geographical Society, New York, receives $5,000 for the founding of a medal to be given for distinguished geographical services.

A PRELIMINARY meeting of the members and fellows of the American Association for the Advancement of Science resident in or near New York City was held at Columbia University on October 24th, to make preliminary arrangements for the meeting of the Association to be held in New York during the last week in June, 1900. The business transacted included the election of an executive committee as follows: Professor J. J. Stevenson, Chairman, Professor J. McK. Cattell, secretary, Mr. Geo. F. Kunz, treasurer, Professor H. F. Osborn (entertainment), Professor N. L. Britton (excursions), Mr. C. F. Cox (transportation), and the general

officers of the Association resident in New York. Professor R. S. Woodward, president; Professor W. Hallock, secretary of the council; Professor J. F. Kemp, chairman of the geological section, and Dr. R. T. MacDougal, secretary of the botanical section.

MR. O. F. COOK of the Division of Botany, Department of Agriculture, has been detailed to make a preliminary examination of the plant products of Puerto Rico with reference to the introduction of new and useful tropical plants into that island. Mr. Cook is accompanied by Mr. G. N. Collins of the Department of Agriculture as photographer, and by Mr. George P. Gall, who is sent by the Smithsonian Institution to collect material for the National Herbarium. The expedition left New York on October 28th by the United States transport MacPherson.

MR. R. E. Snodgrass, assistant in entomology in Stanford University, and Mr. A. H. Heller, student in zoology, have just returned from a ten months collecting trip to the Galopagos Islands. The collections are large; birds, fish and insects and spiders being represented by especially large numbers of specimens. The collections belong to Stanford University under whose auspices the expedition was made.

PROFESSOR HENRY S. CARHART, of the department of physics of the University of Michigan, who is absent on leave, is at the Physical Technical Institute, Berlin. He is comparing the electromotive force of the standard Clark cell with that of the standard cell of the Institute.

THE following members of faculties of the University of Michigan, who were absent from the University last year on leave, have returned: Professor Volney M. Spalding, of the department of botany; Alexander Ziwet, junior professor of mathematics; George W. Patterson, junior professor of physics, and Perry F. Trowbridge, instructor in organic chemistry. During his absence abroad the degree of Ph.D. (Munich), was conferred on Professor Patterson. His thesis, which is entitled 'Eine Experimentelle und theoretische Untersuchung des Selbstpotentials,' is published in the October number of *Wiedemann's Annalen*, Leipzig.

PROFESSOR BALDWIN SPENCER has been appointed honorary director of the National Museum at Melbourne in succession to the late Sir Frederick M'Coy. The trustees of the Museum believe that it should be removed to a more central site.

THE Bradshaw lecture of the Royal College of Surgeons will be delivered by Mr. H. G. Howse, who will take as his subject 'A Centennial Review of Surgery.'

A LARGE and valuable collection of paintings of the fishes inhabiting the fresh and salt water about Japan is being exhibited in the museum of the University of Michigan. The collection was a present to the University by Frederick Stearns, of Detroit. The paintings are in water colors and are the work of a Japanese artist.

GRANTS have been made from the Moray endowment of the University of Edinburgh to Professor E. A. Schäfer for purposes of research on the central nervous system, and to Dr. John Malcolm for purposes of research on the alterations in bone marrow produced by nucleins and their allies.

DR. JAMES H. LEUBA, of Bryn Mawr College, has compiled a card catalogue of psychology containing about 10,000 titles. The catalogue consists of the contents of periodicals from 1860–1899. The periodicals selected are not confined to those devoted to psychology, but include many journals, such as *Nature*, the *American Journal of Science*, etc., in which psychological articles might be readily overlooked. There are, indeed, many journals omitted, such as the German physiological archives, but it is hoped that these may be indexed at some future time. Dr. Leuba offers to supply mimeographed copies of the catalogue on standard cards at a price not to exceed $50.00.

MR. W. A. SNOW, late instructor in entomology, in Stanford University, was drowned October 10th in San Francisco harbor. He was swept overboard from a small launch while greeting General Funston and the 20th Kansas Volunteers, just returned from Manila. Mr. Snow was a son of Chancellor F. H. Snow of the University of Kansas, and had been an instructor in entomology in the University of Kansas, the University of Illinois, and Stanford

University. He had published several systematic papers on the Diptera.

Professor J. B. Carnoy, of the Catholic University of Louvain, died at Schuls in the Engadine on the sixth of September. He was well known by his uncompleted manual of *Biologie cellulaire* and by his memoirs upon development of the sexual elements. He also founded the journal *La Cellule.* His writings were characterized by great lucidity but also by a marked positiveness and by a polemical tone which sometimes caused his assertions to be received with reserve. He was nevertheless an able and conscientious observer.

Mr. Grant Allen died on October 25th. He was born at Kingston, Ont., in 1848, and was well known, both for his writing on popular science, and more recently for his novels and other literary works. His books on 'Physiological Æsthetics' (1877) and the 'Color-Sense' (1879) promised serious contributions to science, and his work on the 'Evolution of the Idea of God' (1897) was an anthropological study of value, but most of his books and articles, which are extremely numerous, are of a popular character devoted especially to explaining the doctrine of evolution.

The date of the celebration of the centenary of the Royal College of Surgeons in England has been fixed for July 25th, 26th and 27th, 1900.

The National Geographic Society, Washington, announces the following lectures during November and December:

The popular course: November 3d, 'The Alaskan Boundary,' by Hon. John W. Foster; November 17th, 'Arctic Explorations in 1898–'99,' by Walter Wellman; December 1st, 'Glaciers of Alaska seen by the Harriman Expedition,' by Dr. G. K. Gilbert; December 8th, 'The Philippine Islands,' by Hon. John Barrett; December 15th, 'Natives of the Philippines,' by Professor Dean C. Worcester.

The technical course: November 10th, 'Tide-Levels of the Great Lakes,' by Mr. A. J. Henry; November 24th, 'Explorations in Patagonia,' by Mr. J. B. Hatcher; December 22d, 'Gila River and its Irrigation Possibilities,' by F. H. Newell.

Succeeding lectures for which partial arrangements have already been made will be announced on January 1st.

The *British Medical Journal* announces that during the coming session of the Pathological Society of London an important new departure will be made in regard to the meetings of this Society. Four of the fifteen meetings which have hitherto been held at the rooms of the Royal Medical and Chirurgical Society are to be held at different London laboratories, in connection or not, with medical schools, the object being that demonstrations may be given which it would be extremely difficult or impossible to carry out elsewhere. This is the realization of a proposal made some years ago by the late Professor Roy. It has, moreover, been determined that the report of an author's communication or demonstration given at any of the four laboratory meetings shall be made public only if the author himself so wish. The chief reason for this regulation is that the work being carried out at laboratories may be at such a stage of progress when brought forward that its publication would be premature and injudicious. The next meeting of the Society will be held at the Jenner Institute of Preventive Medicine on November 7th, and subsequent laboratory meetings will be held at University College, London (February 6th), at the Laboratories of the Royal Colleges of Physicians and Surgeons (March 6th), and at King's College (May 1st).

It is expected that the Chicago Drainage Canal, carrying the waters of Lake Michigan to the Illinois and Mississippi Rivers, will be open in December. It was constructed, in the first instance, to divert the sewage of Chicago from Lake Michigan, from which the city draws its water supply, but it may also be used as a ship canal, if the Illinois River is deepened, connecting Chicago and New Orleans. The canal is 35 miles in length, over 150 feet in width, and 20 feet deep, and has been constructed at a cost of about $30,000,000.

An Institute for the study of malaria has been established at Merv as a department of the St. Petersburg Institute of Experimental Medicine. The staff consists of a director with three assistants.

Nature states that in compliance with the request made by Russian men of science to the

Russian imperial authorities, the scientific exploration of the coast-line of the Pacific in the Far East is to be undertaken. It has been arranged that a distinguished zoologist and member of the Imperial Russian Geographical Society shall undertake the exploration at the cost of the Society, in conjunction with the Ministry of Agriculture. The expedition intends to make investigations with a view to classifying the marine fauna and flora on the coast of the Russian territory, and the conditions of zoological life will also be investigated upon the Liao-Tong peninsula, and in the adjacent regions of Manchuria and Korea. The period for these investigations has been fixed at two years, and the the cost of the expedition is estimated at 12,000 roubles. The Geographical Society has promised to make a grant of 7,500 roubles towards this sum, and the Ministry of Agriculture and Imperial Domains will contribute the remaining 4,500 roubles. The Ministry of Agriculture has been led to take a part in this expedition in the expectation that its results will be of great service in developing the coast industries of the Amur and the Island of Saghalien, and also in the districts which have been acquired lately by the Russian government. The Geographical Society also entertains great hopes of the successful results of this expedition, in view of the fact that the previous expeditions sent by it to investigate the Black, Azov and Marmora seas were particularly successful. The expedition to the Far East will work in conjunction with the Society for Exploring the Amur Territory, and intends to establish at Vladivostock a zoological station for studying the marine fauna of the district.

PROFESSOR J. MILNE writes to *Nature* that unusually large seismograms were obtained in the Isle of Wight on September 3d, 10th, 17th, 20th and 23d. The first three refer to disturbances originating in Alaska. The fourth refers to disasters in Asia Minor, and the last to an earthquake having an origin as distant as Japan. Since the 23d, in the Isle of Wight, and also at Kew, not the slightest movement has been recorded. The inference is that the great earthquakes reported as having taken place at Darjeeling on the night of September 25–26th are at the most small and local, and are not likely to have been recorded outside the Indian Peninsula. It is extremely likely that the tremors noticed in Darjeeling were due to landslides, and seismic phenomena were entirely absent.

UNIVERSITY AND EDUCATIONAL NEWS.

DR. BENJAMIN IDE WHEELER, recently professor of Greek in Cornell University, was inaugurated President of the University of California on October 25th. Addresses were made by President Jordan, of Stanford University; President Gilman of the Johns Hopkins University, and President Wheeler.

BY the will of the late Cornelius Vanderbilt, of New York, Yale University receives $100,000 and Vanderbilt University $50,000.

MR. CHARLES HOLCROFT has given £20,000 for the new Birmingham University. Other smaller gifts have also been announced, bringing the total endowment to £315,400. The endowment of Mason College of £200,000 will be transferred to the University, giving it a total endowment of over £500,000.

IT is proposed to enlarge the Durham University College of Science at a cost of £50,000. About £10,000 for this purpose was recently subscribed at a preliminary meeting.

THE attendance at Harvard University, not including Radcliffe College and the Summer School, is this year in all 4,067 students, an increase of 155 over last year. The numbers in the different classes and schools are as follows:

	1898–'99.	1899–'00.
Seniors	369	311
Juniors	335	351
Sophomores	508	507
Freshman	471	497
Specials.	168	190
Totals	1,851	1,896
Science School	415	494
Graduate School	322	315
Divinity School	26	27
Law School	551	604
Medical School	560	550
Dental School	139	132
Veterinary School	25	24
Bussey Institution	23	25
Totals	3,912	4,067

The registration at Columbia University is as follows:

	1898.	1899.
The College	387	439
Law School	342	369
Medical School	697	743
School of Applied Science	431	431
Faculties of Political Science, Philosophy and Pure Science,	262	256
Teachers College	234	272
Barnard College	257	258
	2610	2768

The registration in the several departments of the University of Michigan is as follows:

Literary Department	1,279
Law Department	782
Medical Department	469
Engineering Department	268
Dental Department	246
Pharmaceutical Department	75
Homœpathic Department	68
Total	3,187

It is estimated that the total enrollment at Cornell University will this year be 3,000, as compared with 2,543 last year.

According to the Allahabad *Pioneer Mail*, as quoted by *Nature*, during the past year, no fewer than 11,000 candidates presented themselves for the various examinations of the Madras University, and of these slightly over 4,000 were successful. The fees paid by candidates amounted to nearly Rs. 1,87,000; while sundry items, including about Rs. 10,000 interest on Government securities swelled the income of the University to a little over two lakhs of rupees. The total expenditure for the year came up to Rs. 1,80,000, of which sum Rs. 1,38,000 were absorbed by examiners' fees. The Arts Examinations, as usual, yielded the greatest portion of the University income—the total fees realized from candidates amounted to over one and a half lakhs of rupees, while payments to examiners came up to Rs. 90,000. The Law Examinations yielded a quarter of a lakh of rupees, while the examiner's fees only amounted to slightly over half this sum. The Medical and Engineering Examinations, however, are conducted at a loss; but, after balancing receipts and expenditures, the University realized a net profit during the past year of Rs. 10,000, without reckoning the Rs. 10,000 accruing as interest from Government securities.

At Harvard University Mr. R. J. Forsythe has resigned his position as instructor in metallurgy, and his place has been taken by Mr. Albert Sauveur. C. H. White has been reappointed an assistant in mining. Mr. G. S. Rayner has been appointed to take charge of the mining laboratory.

Caleb Y. Harrison, Ph.D. (Johns Hopkins, 1898), has been appointed professor of machine design in the University of Wisconsin.

Frank B. Sanborn has been elected assistant professor of civil engineering at Tufts College.

The new instructors and assistants in the several departments of chemistry of the University of Michigan are as follows: Eugene C. Sullivan, Ph.D., instructor in organic chemistry; George A. Hulett, Ph.D., instructor in general chemistry; Harrie N. Cole, assistant in qualitative chemistry; Fred L. Woods, assistant in quantitative chemistry; Norman F. Harriman, assistant in chemical technology; Harry M. Gordin, Ph.D., assistant in chemical research; Howard B. Bishop, laboratory assistant in chemistry; Arthur M. Lindauer, assistant in organic chemistry; Alfonso M. Clover, B.S., assistant in general chemistry, and George M. Heath, Ph.D., assistant in pharmacy. The title of Moses Gomberg, Sc.D., has been changed from instructor in organic chemistry to assistant professor in organic chemistry.

Lord Rosebery has been elected rector of Glasgow University by 829 votes to 515 votes cast for Lord Kelvin.

At Cambridge University Mr. W. L. H. Duckworth, M.A., has been appointed to the University lectureship in physical anthropology.

Alfred Tingle, S.B. (London & Aberdeen), Ph.D. (University of Pennsylvania), has become instructor of chemistry in the University of Wisconsin.

Dr. Gustav Rosch has been appointed professor of electro-technology at the Technical School, at Aachen.

Dr. Sigmund Fuchs, assistant professor of physiology at the University of Vienna, has been appointed professor of the anatomy and physiology of domestic animals at the Agricultural Station, at Vienna.

ISAAC LEA.

SCIENCE

FRIDAY, NOVEMBER 10, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*SCIENTIFIC WORK OF THE LICK OBSERVATORY.**

INSTRUMENTS AND SCIENTIFIC WORK OF THE OBSERVERS.

THE nature of the scientific work undertaken at the Lick Observatory is determined by such considerations as the unusually fine atmospheric conditions which prevail here, the nature of the instrumental equipment, and the number of observers on the staff. The general policy of the Observatory is to carry on investigations which cannot be pursued to so great advantage elsewhere. Thus, comets which are bright enough to be easily seen at the leading observatories receive only occasional attention, while comets which, by reason of their faintness or unfavorable position, are difficult of observation, are followed as closely as possible. Elaborate investigations dealing with large masses of data, and requiring a large force of computers, can only be undertaken by richly endowed observatories or by those which receive government assistance. The Lick Observatory makes the most of its natural advantages; and extended theoretical researches, which can be made as well in a city as at a fine observing station, do not form a part of our general plan.

As all the principal instruments of the

* Extract from the forthcoming report of the Director of the Lick Observatory to the President of the University of California, for the year ending Sept. 1, 1899.

Observatory are used on practically every clear night, the amount of work accomplished is very considerable, notwithstanding the smallness of the observing force, while the variety of instruments makes the field covered quite a wide one.

THE THIRTY-SIX-INCH REFRACTOR.

This splendid instrument is in perfect order. A small periodic error originally in the driving-gear has been almost wholly corrected by Professor Campbell (who has charge of the instrument), by introducing into the clock-train a periodic error of equal amount but opposite sign, so that the two errors neutralize each other.

About half the time of the 36-inch equatorial is devoted to spectroscopic determinations of the motions of stars in the line of sight, with the aid of the Mills Spectrograph. This department of the scientific work of the Observatory, which is probably as important as any work that can be done at the present time with a large telescope, has been admirably systematized by Professor Campbell, who is assisted in the observations and reductions by Mr. Wright. The probable error of a single determination is only about 0.25 kilometer for the best stars, a degree of accuracy which has never before been reached in such measurements. A correcting lens, which is placed in the cone of rays from the 36-inch objective, and which changes the chromatic aberration of the telescope so as to adapt it to photographic work, has added somewhat to the accuracy and very much to the convenience of the observations.

During the past year 522 spectrograms were obtained. Over 200 spectrograms were definitively, and about 500 approximately, measured and reduced.

In connection with this work, the following stars have been found to have variable velocities in the line of sight, and therefore to be revolving stellar systems:

η Pegasi, χ Draconis, o Leonia, ξ Geminorum, ι Pegasi, θ Draconis, ε Libræ, β Capricorni, h Draconis, λ Andromedæ, ε Ursæ Minoris, ω Draconis, α Ursæ Minoris, α Aurigæ, υ Sagittarii.

From 25 to 30 spectrograms of each of these stars are needed for determining the orbits. The observations of several of them are essentially complete, and the others are being observed as rapidly as circumstances will permit. An investigation of the orbit of η Aquilæ, based on all the available data, has been made by Mr. Wright, who has also partially computed a set of tables for facilitating the reduction of spectroscopic observations.

Two of the stars in the above list are of special interest. In the case of Polaris the velocity in the line of sight has a double period; a short oscillation, having a range of four miles per second and a complete period of 3 days 23 hours, is superposed on a much longer one, the period of which has not yet been determined, though it is probably as much as several years. The star is therefore a part of a triple system, two of the bodies being dark. Capella, or α Aurigæ, has a double spectrum. The two sets of lines undergo a periodic relative displacement.

To aid in the observations and reductions in this important part of the Observatory's work another assistant is greatly needed. It is a severe strain on both the present observers to keep the work in as satisfactory a state as it is at present.

A special study by Professor Campbell of the triple hydrogen lines in the spectrum of o Ceti led to many interesting results.

The 36-inch telescope has also been used for other spectroscopic investigations. The spectra of all sufficiently bright comets have been photographed by Mr. Wright. Observations of nebular spectra have been made by the Director and others. A comparison of the spectrum of hydrogen in a Geissler

tube with the spectrum of hydrogen in the Orion Nebula, by methods devised by Messrs. Campbell and Wright, led to some interesting results, which have been published, with other spectroscopic papers, in the *Astrophysical Journal.*

For the remaining half of the time the telescope has been used for micrometric work by Professor Hussey, Mr. Perrine and Mr. Aitken, and occasionally by other observers. Series of observations of the satellites of Neptune and Mars have been made by Professor Hussey; of the satellites of Neptune and Uranus by Mr. Aitken. One hundred and fifty sets of measures of planetary nebullæ, for parallax, and a set of measures for determining a possible refractive effect on stars by the head of Swift's comet, have been made by Mr. Perrine.

The 36-inch telescope is also used for the observation of comets, and sometimes, particularly in the case of expected comets, for purposes of discovery. Thus Wolf's periodic comet was discovered by Professor Hussey, and Temple's second periodic comet and Holmes' periodic comet were discovered by Mr. Perrine, with this telescope. In the course of his cometary observations Mr. Perrine has found one close double star and about thirty new nebulæ. The formation of a second nucleus in the head of Swift's comet was also discovered by him on May 11th.

Double stars are regularly observed with the 36-inch telescope, but they will be considered in connection with the smaller (12-inch) instrument.

THE CROSSLEY THREE-FOOT REFLECTOR.

After many experiments, changes and minor improvements, this telescope has been brought into excellent working order. It is in the personal charge of the Director, who is assisted by Mr. H. K. Palmer. It will be used for various astrophysical researches, and more particularly for the photography of nebulæ, for which purpose it has proved to be admirably efficient.

Some of the improvements which have been made are as follows: The pier has been cut down two feet, greatly increasing the facility with which the instrument can be handled. A new and powerful driving-clock has been made by the Observatory instrument maker, from designs by Professor Hussey. The double-slide guiding apparatus and the slow motions have been repaired and improved, and electric illumination provided for the former. Wires for electric lighting and for telephone communication have been run to the main Observatory. The study and the photographic room have been fitted up in a convenient manner for work. A very rigid declination clamp has been added to the mounting. The observing slit in the dome has been fitted with an adjustable wind-screen, on the general plan of the one used at the Yerkes Observatory.

The interior walls of the dome have been painted bright red; the inner surface of the dome itself, black. By means of a large red lamp on a movable stand, the interior is sufficiently lighted for the convenience of the observers, without danger of fogging the sensitive plate. These precautions are necessary, because the 'tube' of the Crossley reflector is merely a framework of iron rods, which does not exclude the light like the tube of an ordinary telescope.

Observation with the Crossley reflector is subject to more limitations than observation with the other instruments. Work cannot be pursued on moonlight nights, in slightly foggy, or even in damp weather. Nevertheless, about 70 photographs have been made of 40 different nebulæ and star-clusters, mostly with long exposures of from three to four hours each, and from the most interesting of these, positive enlargements have been made on glass. The definition of these photographs, and the amount of

detail shown by them, are surprising. Many new features are shown, and some general conclusions of the highest interest have already been drawn. From one to sixteen new nebulæ have been found on nearly every plate exposed, and I have estimated that the number of new nebulæ in the sky, within reach of the Crossley reflector, may be something like 120,000. A set of photographs made with the Crossley telescope was exhibited at the conference of astronomers recently held at the Yerkes Observatory, and has since been presented to the Royal Astronomical Society.

An investigation in the distribution of stars in the Great Cluster in Hercules, by means of a photograph taken with the Crossley telescope, has been made by Mr. Palmer.

Following a method which I proposed some years ago, the Crossley telescope has been used to produce photographs of the Great Nebula in Orion, by means of the less refrangible rays of the spectrum, which are directly comparable with drawings. The results are in confirmation of earlier spectroscopic observations made here, and may be regarded as an extension of the spectroscopic method to parts of the nebula which are too faint for visual observation.

THE TWELVE-INCH REFRACTOR.

This instrument is in charge of Professor Hussey, who is assisted by Mr. Coddington. A most important part of its work, as well as that of the 36-inch telescope, is the measurement and discovery of double stars, for which purpose the conditions on Mt. Hamilton are especially suitable. Professor Hussey is at present engaged in the remeasurement of all the Otto Struv stars, or double stars discovered at the Pulkowa Observatory. About 2,000 measures have been made in connection with this work up to the present time.

The number of measures of double stars made during the past year is as follows: By Professor Hussey, 996; by Mr. Aitken, 976. Mr. Aitken's list includes nearly all the rapid binary systems.

A systematic search for new pairs has been made by Professor Hussey, mainly with the 36-inch refractor, within the zone 10° to 14° south declination. Thirty-six new pairs were found during the past year, most of them very close, the distance in two cases being only 0.″15.

The zone between 2° and 10° south declination has been examined in a similar manner, with the the 12-inch equatorial, by Mr. Aitken. About 50 pairs have been found since April 1st of the present year. To guard against errors, each new pair has been examined with the 36-inch telescope on at least one night. Only close stars brighter than the 9th magnitude are included in these lists.

With both equatorials the following complete sets of comet observations have been made during the year ending September 1, 1899:

Comet.	*No. Obs. and Observer.*
1898, I. (Perrine).	21, Perrine.
1898, IV. (Wolf).	8, Hussey.
1898, VII. (Coddington)	9, Coddington.
1898, VIII. (Chase).	1, Aitken, 36 Coddington.
1898, IX. (Perrine).	20, Perrine.
1898, X. (Brooks).	19, Hussey.
1899, a (Swift).	7, Hussey; 17, Perrine.
1899, b (Tuttle).	13, Perrine.
1899, c (Tempel II.).	2, Hussey; 10, Aiken. 31, Perrine.
1899, d (Holmes).	5, Aitken; 9, Perrine.

Total number of comet observations, 208.

At the request of Professor Simon Newcomb, the asteroids discovered by Professor James C. Watson have been observed for the National Academy of Sciences. The work has been done by Mr. Coddington. In general, ephemerides were computed from the data given in the *Berliner Jahrbuch.* The region indicated by the ephemeris was photographed with an exposure of one hour

or more with the Willard 6-inch lens, and the asteroid identified on the negative by the trail caused by its proper motion. It was then observed with the 12-inch telescope. All but two of the Watson asteroids (or three, counting the one that is 'lost') have been rediscovered and observed in this way. From three to five observations have been made of each. In the course of the work Mr. Coddington discovered two new asteroids; (439) Ohio, and (440).

Thirty-seven observations of ten other asteroids have been made by Mr. Coddington, seventy-nine observations of five asteroids by Professor Hussey (including sixty-five observations of the new planet Eros), and ten observations of two asteroids by Mr. Palmer.

THE 6½-INCH MERIDIAN CIRCLE AND THE 4½-INCH TRANSIT INSTRUMENT.

The Meridian instruments are in charge of Professor Tucker, who is assisted by Mr. Crawford. The transit instrument has been little used, as the clock corrections for the time-service have been furnished by the meridian circle.

During the year ending September 1, 1899, 6,000 observations on 106 nights have been made with the meridian circle, mostly of southern stars from the catalogue of Piazzi. In addition to these, observations for a study of the refraction were made during two months by Mr. Crawford, who has also been regularly employed in computation. The reductions have been carried through the early stages for all the observations of the Piazzi stars, and have been completed for about 1,000 observations. A few miscellaneous observations of comparison stars and asteroids have also been made.

The manuscript of the meridian circle results from 1893 to 1896, forming volume IV. of the Publications of the Lick Observatory, has been sent to the State Printing Office.

THE CROCKER PHOTOGRAPHIC TELESCOPE (SIX-INCH WILLARD LENS).

This instrument, in charge of Mr. Coddington, has been employed mainly in the re-discovery of the Watson asteroids. Photographs have also been made of nebulæ, and of comets 1899, a (Swift) and 1898, X. (Brooks).

THE FLOYD TELESCOPE, AND SIX-INCH PORTRAIT LENS.

These two instruments, which are carried by the same equatorial mounting, have been in charge of Mr. Palmer, who has employed them, at such times as could be spared from other duties, in photographing the extended nebulosities of Herschel; also, in photographing other nebulous regions, in connection with the work of the Crossley reflector. Photographs were also made of comet 1899, a (Swift), and 1898, X. (Brooks).

THE BRUCE 6½-INCH COMET SEEKER AND THE 4-INCH COMET SEEKER.

The comet seekers, in charge of Mr. Perrine, have been constantly employed. For two months during the past summer they were used by Mr. Crawford.

The comets discovered at Hamilton during the year ending September, 1, 1899 were

Comet, 1899, IX. (Perrine), September 12, 1898.
Comet, 1899, c (Tempel, II.), Perrine, May 6, 1899.
Comet, 1899, d (Holmes), Perrine, June 10, 1899.

In the year ending September 1, 1898, six comets were discovered at Mt. Hamilton.

THE PHOTOHELIOGRAPH.

Two photographs of the sun are taken with this instrument every clear day, and the negatives are stored for future reference. The work has been done by Mr. Pauli, the Janitor.

THE SEISMOGRAPHS.

The seismographs, in charge of Mr. Perrine, are always kept in adjustment. A

spare seismograph has been loaned to the U. S. Observatory at the Mare Island Navy Yard, on the condition that records and reports of earthquake shocks shall be sent to Mt. Hamilton. Several observers, mostly in the neighborhood of San Francisco, also kindly send reports. The collected results are published yearly by the U. S. Geological Survey.

METEOROLOGICAL INSTRUMENTS.

Meteorological observations are made three times daily. Monthly summaries are furnished to the U. S. Weather Bureau. The daily records of the self-recording instruments are filed for future reference.

The time-service has been conducted as heretofore.

MISCELLANEOUS OBSERVATIONS AND COMPUTATIONS.

The Leonid meteors were observed and chartered by several members of the Observatory staff in November, 1898. The results were sent to Harvard College Observatory for discussion in connection with other data.

The reduction of Professor Schaeberle's meridian observations has been in the hands of Mr. Aitken. During the year the Right Ascension and Mean Place reductions were completed, the separate observations made in each year were collated and the discrepancies removed. The Coast Survey stars were reduced to the epoch 1880, the observations of different years collected, and the final places checked by comparison with other catalogues. The Struve stars are now being reduced to the epoch 1880, and the entire work will be completed during the present year.

Two orbits and ephemerides for comet 1898, IX. (Perrine), were computed by Mr. Perrine.

Elements and ephemerides for comet, 1898, V. (Giacobini), and for comet, 1898, X. (Brooks), and elements for comet, 1899, a (Swift) were computed by Professor Hussey.

The definitive orbit of comet, 1896, III. (Swift), was computed by Mr. Aiken.

An orbit and ephemeris for comet, 1898, VIII. (Chase), were computed by Mr. Coddington and Mr. Palmer.

A computation of the definitive elements of comet, 1897, III. (Perrine), is being made by Mr. Palmer.

Orbits and ephemerides of the new asteroids (439) and (440), and ephemerides for most of the Watson asteroids, were computed by Mr. Coddington.

Two sets of elements for the planet Eros, and circular elements of the asteroids (439) and (440), were computed by Professor Hussey.

Announcements have been telegraphed to Harvard College Observatory, for distribution, at various times.

Measurements of the wave-lengths of lines in the spectre of third type stars, and of the positions of nebulæ on plates taken with the Crossley Reflector, have been made by Mr. Palmer.

A report on the Crocker Eclipse expedition to India is being prepared by Professor Campbell. * * *

James E. Keeler.
Lick Observatory.

THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.

II.

Among our honorary fellows is the name of one who was not only a founder* of the Association of American Geologists in 1840, but also a founder of our own Association,

* The following quotation concerning the formation of the Association of American Geologists is given in a sketch of Professor James Hall, accompanied by an engraved portrait on wood that appeared in the *Popular Science Monthly*, Vol. XXVI., p. 122, November, 1884: "The comparison of observations and interchange of views led to the opening of correspondence,

and until the meeting of the American Association in Boston last year, our senior past president. I refer, of course, to that Nestor of American geologists, James Hall. It was but natural that he should be called to preside over the meeting in the city of his chosen residence. The second Albany meeting was held late in August, in 1856, and must ever remain a memorable one in the annals of American science on account of the inauguration of the Dudley Observatory at that time. It is no purpose of mine to consider the unfortunate controversy that followed that event, involving as it did the names and reputation of four great presidents of our Association—Henry, Bache, Pierce and Gould, but no student of the history of American science can well ignore its existence.

HALL.

Hall was born of English parents in Hingham, Massachusetts, in September, 1811, and after the usual schooling was about to prepare himself for the medical profession, when in 1831 his interest turned toward natural science and he entered the Rensselaer School in Troy, where he was graduated in 1832. It was there that he came under the influence of Amos Eaton, and, like Torrey, profited by it. His connection with the Rensselaer Polytechnic Institute did not cease on graduation, for he was made an assistant, and later became professor of geology, which chair he retained until 1876, when he was made *emeritus*. Thus his loyalty to his *alma mater* continued for nearly seventy years, and was only severed by his death.*

His real life-work, however, was in connection with the Geological Survey of New York, which was organized and divided into four divisions in 1836. Hall was made an assistant geologist and assigned to the second division under Ebenezer Emmons. A year later he was appointed one of the State geologists, and assigned to the charge of the fourth district. He began his explorations in the western part of the State, and from 1838 to 1841 prepared the annual reports of progress in the work of his district. His final report, issued in 1843, as Geology of New York, Part IV., contains, according to T. Sterry Hunt, a description "in a very complete and exhaustive manner the order and succession of the strata, their mineralogical and lithological characters, and the organic remains which they contain."†

Retaining the title of State Geologist, he was in 1843 given charge of the paleontological work of the State survey, and the results of his many years of study have been given to the world in the thirteen volumes of the Natural History of New York, which bear the subtitle of Paleontology. These volumes have received the well-deserved encomium of being "the most comprehensive work of the kind which any state or country in the world possesses." ‡

The first appropriation—$15,000—that was made for this work was with the understanding that it should be completed for that sum, but again and again as the work progressed Hall appealed to the legislature for additional funds for its completion, until in 1894, it was estimated that the entire

by a formal resolution of the New York Board, with other geologists, especially with those engaged in State surveys, of which several were then in progress. This correspondence led to an agreement for a meeting of geologists in Philadelphia in the spring of 1840, and this assemblage, of less than a score of persons, led to the organization of the Association of American Geologists, which, at a later period, on the occasion of its third meeting, added the term Naturalists; and, finally by expanding its title, it became the American Association for the Advancement of Science."

* Biographical Record of Rensselaer Polytechnic Institute.

† T. Sterry Hunt in the American Cylopædia, Vol. VIII., article James Hall.

‡ *New York Times*, August 9, 1898.

work had cost the State over $1,000,000. His comprehensive studies on the paleontology of New York naturally demanded researches beyond the limits of the State, and these he extended westward to the Rocky Mountains. It is now generally admitted that his investigations 'have served as the basis of all our knowledge of the geology of the Mississippi Basin.' *

In 1855 he was offered charge of the paleontology of the Geological Survey of Canada, with the promise of succeeding Sir William E. Logan as director on the retirement of the latter. When he was about to accept, promises of more liberal appropriations from the legislature of New York, and the influence of many leading American scientists, including Louis Agassiz and James D. Dana, led to his declining the offer, a decision which as the promises were never realized, he came to regard as 'the great mistake of his life.' †

The splendid work which he did in New York led to the request for his services elsewhere, and he was appointed to the charge of the Geological Survey in Iowa, in 1855, and to that of Wisconsin in 1857, preparing reports on both of these surveys. The paleontology of several government exploring expeditions was referred to him for discussion, notably that of Frémont, that of Stansbury, that of the Mexican Boundary Survey, and that of King's exploration of the fortieth parallel.

In 1866 the New York State Museum was reorganized, and Hall was made director, a place which he then held until 1893, retaining, however, until his death, the office of State Geologist. It was at our Buffalo meeting, in 1896, that special commemoration exercises were held in honor of the sixtieth anniversary of Hall's connection with the Geological Survey of the State of New York, and at that time papers were read descriptive of his work. W J McGee described him as the 'founder of stratigraphic geology and applied paleontology in America.' * Referring to Hall's study of the crystalline stratified rocks he also said: "It is not too much to say that the method was established by the New York Survey, and that it finds its best illustration in the classic fourth district; here it was that American stratigraphic geology was founded." †

It was also Hall, who, according to Hunt, "laid the grounds for a rational theory of, mountains, which must be regarded as one of the most important contributions to geological science." ‡

He died in August, 1898, and the "monument of the man himself is builded in the rocks of New York, a monument more enduring than bronze or gold." §

Our Association is not local to the United States, but American, and at its tenth meeting it was decided to hold the gathering, in 1857, in Montreal, Canada. For president of that meeting Jacob Whitman Bailey was chosen, but early in the year he died, and the vice-president filled his place.

BAILEY.

Bailey was born in Auburn, Massachusetts, and, after a common school education, he entered the United States Military Academy, where he was graduated in 1832. He joined the artillery branch of the service, and for several years was stationed at various army posts. An early fondness for natural science was assiduously cultivated during these years, and he soon returned to West Point, where he was given charge of

* T. Sterry Hunt in the American Cyclopædia. See note 2, p. 20.

† Biographical Record of Rensselaer Polytechnic Institute.

* Science, New Series, Vol. IV., p. 706.

† Idem, p. 702.

‡ American Cyclopædia, Vol. VIII. See note 2, p. 20.

§ Benjamin K. Emerson in Science, Vol. IV., p. 717.

the chemistry, mineralogy, and geology, and later became professor of these branches, an appointment which he then held until his early death.

Bailey was one of the very first in this country to apply the microscope to the study of minute forms of life, and his work on infusorial fossils and the algæ gained for him a high place among contemporary scientists. He was a pioneer on the examination of the deep-sea soundings made by the United States Coast Survey, and his report on that subject is given in one of the early volumes of the Smithsonian Contributions to Knowledge. This series of publications also contains his papers on terrestrial microscopical organisms. His name is associated with many improvements in the construction of the microscope, and the indicator devised by him is one of his most valuable contributions to science.

He died too soon, but not until his work had 'won the approval of naturalists throughout the world.'*

The vacancy created by the death of President Bailey was filled by Alexis Caswell, who was the first vice-president of the Association. It is a matter of record that "he sustained the credit of his country on a foreign soil by his dignified presence and his manly eloquence to the great satisfaction of his associates."†

CASWELL.

Caswell was born in Taunton, Massachusetts, in 1799, and his ancestors were among the first settlers in that place. His paternal grandmother was a direct descendant of Peregrine White, who was born on the Mayflower in 1620. He was graduated at Brown University in 1822, standing first in his class, and then passed to Columbian University in Washington, where for five years he taught both the classics and mathematics. It was in Washington that he made his special studies in theology under the direction of Dr. William Staughton, President of the University.

In 1827, having resigned his chair, he became pastor of the Baptist congregation in Halifax, Nova Scotia, but a year later he relinquished that charge to return to Providence on an invitation from the First Baptist Church there. The chair of mathematics and natural philosophy in Brown becoming vacant, it was at once tendered him, and promptly accepted. For thirty-five years he continued in charge of the scientific instruction in the college of his choice, and then after a few years' rest he was chosen its president, which place he held until 1872, when, on the fiftieth anniversary of his graduation, he resigned.

It was the development of the various departments of science in Brown University that gave Caswell his high reputation among his contemporaries, but he had other claims that were also worthy of recognition. During the winter of 1858–59 he delivered four popular lectures on Astronomy before the Smithsonian Institution that were deemed of such importance as to warrant their insertion in the annual report of that year. His contributions to the young science of meteorology were of permanent value. Beginning with the year 1831, he instituted a series of observations in Providence which he continued until 1868, that were "precise as regards temperature and pressure; and including also much information on winds, clouds, moisture, rain, storms, the aurora," etc.*

I have spoken of his career as a teacher, and I have referred to his contributions to science. In closing this brief sketch it must be added that he was prominent in many walks of life, taking ever an active interest

*Smithsonian Report for 1857, p. 74.

†Memorial of Alexis Caswell, D.D., LL.D., with an engraved portrait on steel, p. 29, being a reprint of the Memoir by Joseph Lovering, presented before the American Academy of Arts and Sciences.

*Joseph Lovering in Memoir, p. 27.

in the welfare of his fellowmen. "In every charitable movement he was foremost with practical advice and generous aid."*

"Few men have filled more eminent positions in the walks of learning and science, and few pass away more cherished in scholarly remembrance than Alexis Caswell."†

WYMAN.

The twelfth meeting of our Association was held in Baltimore, and over that gathering Jeffries Wyman, of Boston, was chosen to preside, but when the time for the meeting came Wyman was unfortunately absent in South America. John E. Holbrook, of Charleston, South Carolina, the vice-president, was likewise unable to be present, and the duties of presiding again fell upon the competent shoulders of Caswell.

Wyman‡ was born in Chelmsford, Massachusetts, in 1814. He was the son of a physician, and after graduating from Harvard in 1833, followed in the footsteps of his ancestors, and with his brother, who still lives, studied medicine, both taking their degrees in 1837. Boston became his home, and several minor appointments came to him, notably, a course of lectures on comparative anatomy at the Lowell Institute, with the proceeds of which he visited Europe, where for two years he studied anatomy under the best masters both in Paris and London.

In 1843 he returned to Boston and soon was appointed to the chair of anatomy and physiology in Hampden-Sidney College, in Richmond, Virginia. The duties of this appointment called him from Boston during the winter and spring months only, and so offered a pleasant change from the rigors of the severer weather in Boston. Five years later he was called to succeed the celebrated John C. Warren in the Hersey chair of anatomy in Harvard Medical College, a congenial post, which he filled with honor until his death.

It would require more knowledge than I possess to properly present to you abstracts of the magnificent memoirs on comparative anatomy that came from the pen of this leader in science. That task, fortunately for the world, has been performed by one who studied with him, and to the memoir presented before the National Academy of Sciences* by Packard, I beg to refer you for that full and adequate treatment which Wyman's work deserves. Two quotations may, however, be given to indicate their value. His study on the gorilla, according to Gray, 'assured his position among the higher comparative anatomists.'† His paper on the bull frog was described as the 'clearest introduction to the most complex of animal structures.'‡

So great was his knowledge of anatomy that a single sentence from Oliver Wendell Holmes sums up fully his remarkable ability to develop a structure from a single bone.

"In a memorial trial [he says] his evidence relating to the bones which had been submitted to great heat is of singular excellence as testimony, and his restoration of fragments is a masterpiece of accuracy and skill."§

Wyman was a man of delicate constitution, and as he advanced in years it became his settled custom to spend the winters in Florida. It was in that land of flowers that he began his archeological work by

*New York Tribune, Jan. 9, 1877.

†*Taunton Gazette*, January 9, 1877.

‡ Biographical Memoirs of the National Academy of Sciences, Washington, 1886. Vol. II., p. 75. Jeffries Wyman, by A. S. Packard. See also *Popular Science Monthly*, Vol. VI., p. 355, where an engraved portrait on wood is given; also see Anniversary Memoirs of the Boston Society of Natural History, Boston, 1880, where a lithograph portrait is given.

* Biographical Memoirs, Vol. II., p. 77.

† Idem, p. 97.

‡ Jeffries Wyman, Memorial Meeting of the Boston Society of Natural History, October 7, 1874, p. 24.

§ Biographical Memoirs, p. 95.

the examination of the shell heaps, then little known, but now recognized as existing at many places along our Atlantic coast. These he studied with much interest and prepared reports on them which were published by the Peabody Museum in Cambridge. Of this institution he was one of the founders and its first curator. His successor and the second curator of that institution, I need hardly add, is President Putnam.

For the meeting in the year 1859 the City of Springfield, Massachusetts, was chosen, and to preside over that gathering Stephen Alexander, of Princeton, was selected by his colleagues.

ALEXANDER.

Alexander was born in Schenectady, New York, in 1806. As a boy he was slender and delicate, fond rather of books than of outdoor sports, and being an excellent student, he was given a college education. He was graduated at Union in 1824 with high honor, although only eighteen years of age. For several years he taught, and then made astronomical observations in Albany, the results of which were communicated to the Albany Academy.

In a sketch * by his successor at Princeton, the inference is made clear that the marriage of his sister in 1830, to Joseph Henry, had much to do with the shaping of his scientific career, for he followed Henry to Princeton in 1832, and then entered the Theological Seminary as a student.

His scientific work was entirely connected with astronomy, and, beginning with 1834, he observed most of the solar eclipses visible in the United States. In 1860 he was made chief of the party that went to Labrador under the auspices of the United States Coast Survey to observe the eclipse of that year, and again, in 1869, he was a leader of the observation party sent to Ottumwa, Iowa. He was associated with Henry in his thermopile observations on sun spots in 1845, as well as in other astrophysical researches, and, to quote from Young:

"He observed four transits of Mercury, and in December, 1892, he closed the record of more than fifty years by a careful and satisfactory observation of the transit of Venus." *

It would be too much to claim that Alexander was a great scientist, but fifty-three years of earnest devotion to his professional duties, added to his valuable contributions to the science of his choice, is a career worthy of high honors. It was well said of him at the time of his death, in 1883, that "American astronomy to-day owes much to his life and labors." †

The unwritten law of alternating the succession in the presidential chair from a representative of the physical sciences to one devoted to natural science received an emphatic demonstration in the selection of Isaac Lea as the successor of Alexander. The searcher for truth in the remote distance of far-away skies gave place to the patient student of fresh-water shells.

LEA.‡

Born in Wilmington, Delaware, in 1792, Lea was early influenced towards a fondness for natural history by his mother, who was devoted to botany. At the age of fifteen the boy was sent to Philadelphia to enter mercantile business, and there met Lardner Vanuxem, the future geologist. The young men spent their leisure in long walks, in which they collected minerals and studied the geological features of the vicinity.

* Biographical Memoirs of the National Academy of Sciences, Washington, 1886, Vol. II., p. 249. Stephen Alexander, by Charles A. Young.

* Biographical Memoirs, p. 254.

† Idem, p. 259.

‡ A Portrait of Isaac Lea is published as a frontispiece.

Then they learned of the Academy of Natural Sciences, and the influences of that institution which had been exerted for so much good among the young men in Philadelphia, was extended to them. Membership was accorded to them in 1815, and two years later Lea presented his first paper before that body.

His interest in mineralogy gradually extended to geology, and especially to paleontology, through which he acquired a special fondness for fresh-water and land shells, to the study of which he devoted first his leisure from business and then all of his time. The unios were specially attractive to him, and his first conchological paper, published in 1827, was a description of six new species of that genus.

From this beginning grew his many papers on that particular mollusk until his separate articles collected under the title 'Observations on the Genus Unio,' 1827–1874, formed thirteen quarto volumes, containing two hundred and eighty plates. Besides the foregoing, he wrote many papers on new species of the Strepomatidæ, Colimaceæ and other forms, indeed, it has been computed that nearly two thousand new species were described by him, of which nearly one-half were unios. His entire bibliography includes almost three hundred titles.

To the few specimens originally collected for study were soon added others that were sent to him from all over the world, and his cabinet, unique of its kind in the world as far as the unios were concerned, was bequeathed by him to the United States National Museum. As a memorial to him it fills the large hall of the Smithsonian Institution, and to students the fruits of his years of devotion to science are ever available, thus carrying out in a practical way the injunction of Smithson's bequest to found an institution for 'the increase and diffusion of knowledge.'

Lea's first love of minerals also followed him through life, and he formed a valuable collection of gem stones. These, like his larger cabinet, have found a permanent home in the National Museum. His special interest in connection with gems was concerning inclusions in crystals, and upon this subject he contributed a number of valuable papers.

The Academy of Philadelphia chose him as its president, in 1858, and two years later he became president of our Association. He lived until 1886, and continued his interest in science until the last. One of the features of the Philadelphia meeting of 1884 was the reception given by Lea to the visiting scientists, both from our own Association and from the British Association, at his summer home.

The long struggle of cruel warfare between the North and the South prevented any meeting of our Association for five years subsequent to the gathering in Newport, and so it was not until 1866 that the members of the American Association were reunited in a meeting held in Buffalo. It was a happy coincidence that for that occasion a president had been chosen in 1860, who at that time was one of the most famous of southern scientists, and who, in consequence of the fortunes of war, turned his steps northward to win even greater laurels as president of Columbia University. I refer, of course to Frederick Augustus Porter Barnard, the selection of whom did credit alike to the men of science, whether from the north or from the south.

BARNARD.

Barnard was born in Sheffield, Massachusetts, in 1809, and his ancestors settled in New England early in its history.* As a

* See Memoirs of Frederick A. P. Barnard, D.D., LL.D., tenth president of Columbia College, by John Fulton, New York, 1896. Also *Popular Science Monthly*, Vol. XI., p. 100, and *Scientific American*, Vol. LVIII., p. 327, May 25, 1889, both of which contain portraits.

boy he learned the printer's art, but not to the neglect of his studies, for he was graduated at Yale in 1828, standing second in his class. At once he began his work as a teacher in the Hartford grammar school, and also took up in Hartford the study of law under Jonathan Edwards. Two years later he returned to New Haven and was made a tutor of mathematics. At that time a severe illness produced a temporary deafness, and as that affliction was hereditary in his family, it led him to retire from Yale and to turn his attention to the education of the deaf and dumb, accepting first a call in an institution in Hartford, and in 1832 to one in New York City.

In 1837 he was invited to the University of Alabama, where he filled, first the chair of mathematics and natural philosophy, and later that of chemistry and natural history, remaining in Tuscaloosa until 1854. It was said of him, at that time, that he was "the best at whatever he attempted to do; he could turn the best sonnet, write the best love story, take the best daguerreotype picture, charm the most women, catch the most trout, and calculate the most undoubted almanac."* As further evidence of his versatility it may be mentioned that he edited two newspapers of opposite political opinions. It was also while in Tuscaloosa that he delivered his famous Fourth of July oration, beginning "No just cause for a dissolution of the Union in any thing that has hitherto happened; but the Union is the only security for Southern rights." While it enraged his colleagues greatly, "this oration, read in every part of the State, as it was within a week, presented the northern cause in an entirely new light in Alabama, and checked the rising spirit of rebellion for many years."†

* Appleton's Annual Cyclopædia, Vol. XIV., p. 73. This was given me originally by Mrs. Barnard.

† Clipping from *The New York Tribune*, probably of July 6, 1886.

In 1854 he accepted a call to the chair of mathematics, natural philosophy and civil engineering in the University of Mississippi, of which institution he became president in 1856, and chancellor in 1858. When the Civil War closed the doors of that University he declined office under the Confederate government and came north. For a time he was connected with the United States Naval Observatory, and also with the United States Coast Survey, but the vacant chair of physics in Columbia College attracted him, and the trustees of that institution were wise in taking advantage of their opportunity to offer him the higher honor of the presidency of Columbia College, a place from which President King had just resigned.

Newberry, who for so long was closely associated with him, in an admirable address, in which he presented a summary of Barnard's career as an educator, said of the growth of Columbia during his presidency: "He made there a noble and an honorable record. Every one of the steps of progress was either conceived or earnestly advocated by him and owed its achievement to his support. He was not only a participant, but a leader in every forward movement."*

In conclusion let me quote the lines that his friends Whittier wrote of him:

> Rich, from life-long search
> Of truth, within thy academic porch
> Thou sittest now, lord of a realm of fact,
> Thy servitors the sciences exact;
> Still listening with thy hand on Nature's keys.
> To hear the Samian's spheral harmonies
> And rhythm of law.

As I approach that period in the history of our Association during which it has been my privilege to know personally the men who were our leaders, the pleasure of pre-

* John S. Newberry. Necrology Report of the University Convention of the State of New York. (Reprint.)

paring this address increases. Barnard was president of Columbia during my undergraduate course there, and perhaps the last time that I saw him was on the occasion of the meeting of the American Association in New York, 1887. Another meeting was yet to come and go, and then Barnard too was called away to join the silent majority.

In that admirable address with which he welcomed the Association to Columbia he reviewed the labors of his many distinguished predecessors in the Association, saying in conclusion:

> All these have gone to their rest, many of them full of years, all of them full of honors. Others have risen to fill their places, no less earnest, no less capable, and destined to be no less illustrious.*

NEWBERRY.

Among all of these there is none of whom I am prouder on this occasion and in this place to express my love and honor for than John Strong Newberry, of whom it was so well said:

> He is a geologist—keen of eye, stout of limb, with a due sense of the value of detail, but with a breadth of vision that keeps detail in due subordination.†

Newberry‡ was born in Windsor, Connecticut, towards the close of the year 1822. He was of early New England ancestry, and was specially proud of the fact that his grandfather was an officer in the American army during the war of the Revolution. The boy was barely two years old when his parents moved to Ohio and Cuyahoga Falls became his home. He was educated at Western Reserve College, and received his doctor's degree from the Cleveland Medical College in 1848, after which he spent two years in special study abroad.

Then settling in Cleveland he began the practice of medicine, but his love for natural science was greater than his fondness for his profession, and in 1855 he accepted an appointment in the United States Army as assistant surgeon. From that time until 1861 he served both in his professional capacity and as a geologist to exploring parties. At first under Williamson who was sent to examine the country between San Francisco and the Columbia River; then under Ives in his exploration of the Colorado River; and finally under Macomb with the expedition sent to study the San Juan and upper Colorado rivers. On the material gathered during each of these expeditions he prepared valuable scientific reports, which were published by the government. In these volumes will be found pioneer work of great value, much of which has been lost sight of on account of the greater development of the same territory by subsequent expeditions. In an appreciative sketch of him by Kemp, his successor at Columbia, that appeared at the time of his death, I find this statement:

> His determinations of strata in the west, although based on the hasty itineraries of exploring parties, have been very generally corroborated by later and more deliberate work.*

His wonderful 'ability to grasp as by intuition the bearings of many widely separated facts,'† would have gained even greater renown for his early work in the west, had not the civil war intervened.

From 1861 to 1866 Newberry was secretary of the Western Department of the United States Sanitary Commission with

* Proceedings, American Association for the Advancement of Science, Vol. XXXVI., p. 342.

† Address made at the presentation to Newberry of the Murchison medal in 1888, by the Geological Society of London. He was the first American geologist to receive that honor.

‡ See sketch in *Popular Science Monthly*, Vol. IX., p. 490, August, 1876, with an engraved portrait on wood, and also *Scientific American*, December 31, 1891, with half-tone portrait.

* In Memorium. Professor John Strong Newberry, *School of Mines Quarterly*, Vol. XIV., p. 90, January, 1893, with two engraved portraits on steel.

† Idem, p. 99.

supervision of all the operations of that body in the valley of the Mississippi. He organized the comprehensive work of the commission in the large section that was entrusted to his care, and during its life expended more than $800,000 in money, besides distributing hospital stores that were valued at more than $5,000,000. The whole story of that wonderful achievement, its development, and its completion was told by himself in his report of the commission in the valley of the Mississippi that was published in 1871.

With the return of peace came a new interest in the development of our institutions of learning, and conspicuous among the newer experiments was the then recently organized School of Mines of Columbia College. It was the first institution of its kind in the United States, and its success was yet to be determined. Newberry was called to the charge of the department of geology in the new school, and, with a faith in its ultimate success that never faltered, he accepted the trust. With the same genius for organization that was shown by his development of the work of the Sanitary Commission, he began the planning of courses of study. Alone he gave instruction in botany, zoology, geology, lithology, paleontology and economic geology, and a quarter of a century later left to the world as his best and greatest memorial a magnificently equipped department of the special branches taught by him not excelled by any similar educational institution in this country. Nor was this all. He created a museum of over 100,000 specimens, principally collected by himself, which served to illustrate his lectures on geology and economic geology. It contains "the best representatives of the mineral resources of the United States to be found anywhere, as well as many unique and remarkable fossils." *

* This is his own description taken from a personal letter written to me in 1888.

Kemp calls it 'a monument to his memory,' and adds:

> Its wealth of fossil fish and fossil plants makes it unique and famous among geological museums.*

In 1869 he became State geologist of Ohio, and for many years he regularly spent his summers in the field, while the accumulated material was digested during the winter months in the laboratory in New York, yielding the nine large volumes of reports published by Ohio. The unwillingness of the State Legislature to permit the completion of the work as originally intended was the great grief of his closing years, and marked the beginning of his end.

It is a pleasure to remember that during the last years of his life he received the fossil plants and fishes from the United States Geological Survey to report on, and so returned to the study of those forms which, as a boy, he loved to collect in the coal deposits of eastern Ohio.

He was rich in those accumulated experiences that we call wisdom. He was a friend, faithful and true, as those who knew him can testify. He is gone, but his influence cannot die. It will live forever to 'reach through nature, moulding men.'

American astronomers hold a high place in the history of the development of their chosen science, and among those in our country who have made the study of the heavens their chief life-work, first place must unquestionably be given to Benjamin Apthorp Gould for his splendid achievements. In his time he ranked as the greatest of our astronomers, and our Association honored itself in choosing him to preside over the meeting held in Chicago in 1868.

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM.

(To be continued.)

THE BEST MOVEMENT FOR HANDWRITING.

IT is by no means certain that the ordinary writing movement, as taught in the

* *School of Mines Quarterly*, Vol. XIV., p. 99.

schools and used with more or less of individual peculiarity by most adults, represents, for purposes of rapid and legible writing, the best of which the human hand is capable. Every penman will recognize certain difficulties that attend the use of this movement. It is not as easy as one could wish: continued employment of it tends to writer's cramp. It is not as rapid as one could wish. It does not give as good penmanship as one could wish: it is subject to jerks and irregularities, and at high speeds requires so much exertion in making the vertical strokes that it is apt to degenerate into a flat scrawl.

In order to obviate some of these difficulties, another movement has been advocated and largely taught. This is sometimes called the 'American method,' sometimes the 'forearm movement.' In strictness, however, it is not a forearm movement, but a movement of the full arm from the shoulder. This mode of writing has at least one great advantage; it never leads to writer's cramp. It is not liable to cramp because it is made by good-sized muscles, whereas the ordinary thumb and finger movement is largely produced by the little muscles in the hand itself. The full arm movement has another advantage in the boldness and smoothness of its lines. But there is one strong objection to the use of this movement; the parts moved are much larger than is necessary for the end in view, and the amount of energy required is thus absurdly great. When this movement is hastened, it shakes the whole body. And besides this, it is not found to be specially favorable to the union of speed and legibility; it does not obviate the flattening out of the letters.

There is yet a third movement of which the hand is capable—a movement never taught for penmanship, but still possessing certain marked advantages over the movements now in vogue. It may be described as a side-to-side movement of the wrist—adduction and abduction. The forearm may also come into play, and the movement be made partly from the elbow. In order to write by this movement, let the top of a sheet of paper slant over to the right, instead of to the left as in ordinary writing. To carry the hand along the horizontal line, draw the whole arm, in the direction of the forearm, back towards the flank. Meanwhile impart to the wrist (and forearm) a back-and-forth, lateral motion, which shall produce the vertical strokes of the letters. Considerable awkwardness may at first be experienced, and the unusual position and appearance of the sheet will cause the writing to be 'back-handed.' This may be avoided by bending the elbow more sharply, so bringing the hand in rather close to the chest. The paper can then be placed square on the table, and the writing still made with the same movements, though less freely than in the other position. In order to compare the suggested movement with the others, we may reduce writing to its lowest terms, namely, to a series of simple up and down strokes, like a connected row of *m*'s. By the use of this simplified form, we can easily compare the three movements and observe their relative ease, speed and accuracy.

Extensive tests were made by this method,* and it was found that in point of speed the forearm movement averaged 23% better than either of the others. In point of freedom, likewise, it had the advantage, as was seen by the greater lengths of its vertical strokes when the movements were hastened. In regard to accuracy, several points had to be considered. In keeping the alignment, and in uniformity of height,

* This comparison was first suggested incidentally in the course of a study on the accuracy of movements, and the results are more fully reported in a paper entitled 'The Accuracy of Voluntary Movement,' published as Monograph Supplement, No. 13, to the *Psychological Review*.

the forearm movement proved slightly inferior to the more practiced finger movement, and even to the full arm movement. In this particular the full arm movement would, with practice, probably be the best of the three. But in uniformity of slant, the forearm movement was far superior to the others. There were a smoothness and grace in the tracings of this movement that were quite absent from the rest.

These analytical laboratory experiments were obtained with a high degree of agreement from a considerable number of individuals. As to the results of the suggested movement in actual writing, little more can at present be asserted than that the movement is entirely practicable. The few who have tried it are pleased with the results. The writer of this article has himself adopted it largely, and finds realized the advantages that the laboratory experiments gave reason to expect. Rapid writing is freer and more legible, showing no tendency to degenerate into the flat scrawl. Less fatigue is felt; and the muscles employed, though not so large as those of the full arm movement, are large enough to avoid the tendency to cramp. The uniformity of slant gives the page a neat appearance. The alignment is satisfactory. The possession of two movements is at times a great source of comfort. Finally, from the relative facility with which the left hand was found to acquire the various movements, as well as from the fact that the wrist movement is made by the simplest muscular coördination, it seems altogether probable that the wrist movement would possess, over the complex finger movement, the advantage of being more easily learned.

R. S. WOODWORTH.

A CENSUS OF THE FOSSIL VERTEBRATA OF NORTH AMERICA.

THE writer has been able to make such an examination of the literature appertaining to fossil vertebrates, that he feels justified in making a statement regarding the number of genera and species which are known to occur in North America north of Mexico. The writer is not aware that any one else has yet prepared a list of the species of all the groups, and apparently the paleontologists themselves have very vague ideas regarding the number of known species, outside of the groups which they are themselves studying.

It is, of course, recognized that no two men in preparing such a list would arrive at the same results, since their ideas would undoubtedly differ more or less regarding what are to be considered tenable genera and species. In determining whether or not reputed species are to be reduced to synonymy, the writer has in most cases accepted the results of the investigations of other workers, where such results have been expressed clearly and definitely; while in cases of doubt a conservative course has been followed, it being held that it will cause less confusion in nomenclature and bibliography to retain as distinct two forms which must eventually be united, than it will to unite under one name two forms which must in the end be separated.

The whole number of genera which, in the acceptation of the writer, are found in the region indicated is 1118; the whole number of species 3234. These are distributed among the large groups, as shown in table following. It is proper to note that in this list there is included a relatively small number of existing species whose remains have been found in pleistocene deposits of old lakes and of caves, accompanied by remains of other species either now extinct or having a geographical distribution different from the present. A larger proportional number of such living species is found in the group of birds than in any other, there being 33 such species.

GENERA AND SPECIES OF NORTH AMERICAN FOSSIL VERTEBRATA IN THE GROUPS NAMED.

FISHES.

Group.	Genera.	Species.
Elasmobranchii	114	537
Ichthyodorulites*	34	136
Aspidoganoidei†	3	7
Placodermi	18	43
Dipnoi	10	43
Crossopterygia	16	41
Actinopteri	102	303
Total of fishes	297	1110

BATRACHIANS.

Group.	Genera.	Species.
Stegocephali	41	88
Urodela	2	5
Anura	1	1
Total of batrachians	44	94

REPTILES.

Group.	Genera.	Species.
Cotylosauria	12	24
Chelydosauria	2	3
Anomodontia	1	1
Pelycosauria	12	29
Testudines	37	148
Ichthyosauria	5	7
Plesiosauria	14	27
Rhynchocephalia	3	9
Pterosauria	3	8
Loricata‡	17	62
Squamata§	48	126
Dinosauria	65	154
Total of reptiles	219	598

BIRDS.

Genera, 59 ; species, 102.

MAMMALS.

Group.	Genera.	Species.
Protodonta	2	2
Allotheria	13	41
Didelphia	21	44
Bruta	16	36
Sirenia	5	7
Cete	42	77
Condylarthra	9	26
Perissodactyla	43	215
Artiodactyla	75	207
Ancylopoda	3	5
Amblypoda	13	40
Dinocerea	5	33
Proboscidea	2	18
Tillodontia	3	13
Glires	40	99
Insectivora	18	22
Chiroptera	5	7
Creodonta	39	103
Carnivora	55	134
Primates	27	53
Total of mammals	436	1182

Foot-prints : Genera, 63 ; species, 147.

Total of all groups : Genera, 1118 ; species, 3234.

* Mostly, at least, defensive spines of elasmobranchs.

† This name, proposed by Dr. Gill, in 1876, antedates Cope's *Ostracodermi* and *Ostracophori*.

‡ Crocodiles and their allies.

§ Mosasaurs, lizards and snakes.

Of the classes of the list presented above, the birds are conspicuous because of the small number of species represented, the 102 contrasting strongly with the approximately 1100 species now inhabiting North America. It seems not unlikely that the habit possessed by birds of living in the open air and the tendency of their bodies to float for a long time after death have insured their destruction. Doubtless many of the smaller reptiles and mammals have been preserved because they met death in their burrows. A floating bird would be devoured by large fishes and reptiles.

The list of the reptiles is a large one, the two largest orders being those of the turtles and the dinosaurs. The latter owe their preservation mainly to their great size. The turtles are likely to become buried in deposits, because they are mostly inhabitants of the water, they readily sink when dead, and they are not easily devoured.

The mammals present a formidable array. One-half of the groups in the list are extinct, either wholly or from this continent. Those which have here living representatives show many more fossil than living species, excepting the bats, the rodents and the insectivores. The last two groups, being composed mostly of small species, have

probably not yet received their share of the attention of collectors. Of rodents there are now living in North America over 300 species, of bats about 40 species, and of insectivores about 40 species.

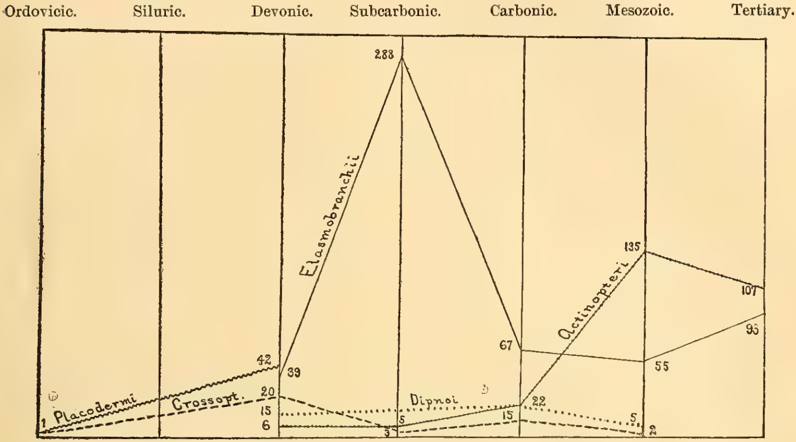


Diagram showing the distribution of North American fossil fishes.

The animals which are included under the general name of fishes furnish such interesting results that an attempt is made to furnish a graphic illustration of the time distribution of the principal groups. In examining this we are at once struck with the enormous development of the elasmobranchs during the Subcarbonic period. Furthermore, from the elasmobranchs presented in the illustration have been excluded the ichthyodorulites, the great majority of which are undoubtedly the defensive spines of shark-like animals. The distribution of the species of these is as follows: Siluric, 2; Devonic, 27; Subcarbonic, 83; Carbonic, including the Permic, 22. Had these been included, the Subcarbonic peak would have been uplifted by an amount equal to two-thirds its present height, while the elevations of the Devonic and Carbonic would not have been greatly increased. The occurrence of so many defensive spines in the Subcarbonic, when such a variety of elasmobranchs is indicated by teeth, is a pretty plain suggestion that in very many cases a genus founded on a spine is identical with some other genus based on teeth; for it is not probable that many of the ichthyodorulite-bearing fishes were toothless. After the Subcarbonic period the elasmobranch line descends rapidly in the Carbonic, slowly in the Mesozoic, and rises slightly in the Tertiary. At the present day there are recognized only about 86 species of elasmobranchs living along the whole American coast, north of Mexico.

Although the ichthyodorulites have been excluded from the elasmobranch species in the illustration, the line has been extended to the Siluric, because of the occurrence of *Onchus* in it.

In like manner the line representing the Placodermi and the Crossopterygia have

been prolonged backward to the Ordovicic, in consideration of Mr. C. D. Walcott's genera *Astraspis* and *Eriptychius*.

In contrast with the elasmobranchs the actinopterous fishes, which entered on their career as 'a feeble folk' in the Devonic, seem hardly to have held their own during the Subcarbonic. Their numbers increased slowly during the Carbonic, the feri then expanded rapidly during the Mesozoic. The slight fall in the number of known species during the Tertiary does not probably indicate an actual reduction in the number of species that then lived. In the waters of the region here contemplated there are now living probably at least 1500 species of this group of fishes.

O. P. Hay.

THE INTERNATIONAL ASSOCIATION OF ACADEMIES.*

For several years past there has existed an Association or Cartell of the Academies of Sciences of Munich and Vienna, and of the Royal Societies of Sciences of Göttingen and Leipzig, which has met yearly to discuss matters of common interest, and the combined action of these bodies has in several ways been fruitful of results. Representatives of the Royal Society of London attended the meeting held last year at Göttingen, as well as that which took place the previous year at Leipzig, chiefly with the object of discussing the project of an international catalogue of scientific literature which the Society has been engaged in promoting.

When the invitation was conveyed to the Royal Society of London to send representatives to the Göttingen meeting, it was intimated that the Cartell would be glad to learn the views of the Society as to the possibility of its joining the Association. The delegates appointed from London were instructed to state that the Royal Society would be disposed to join, provided that the organization were so extended as to assume a truly international character. This suggestion was not only accepted in principle at Göttingen, but it was agreed that the Royal Society of London should be requested to take the steps, if thought desirable, to ascertain how far the establishment of such an international association would commend itself to the leading scientific bodies of other countries.

The Royal Society of Sciences of Berlin, although not included in the Cartell, has for several years past been represented at its meetings. When the Royal Society of London had ascertained that the project was likely to find favor, it was agreed that the Royal Society and the Berlin Academy should together issue an invitation to the Academy of Sciences, Paris, the Imperial Academy of Sciences, St. Petersburg, the Reale Accademia dei Lincei, Rome, the National Academy, Washington, as well as to the bodies included in the Cartell, requesting them to send delegates to a conference to be held in Wiesbaden on the 10th and 11th of October.

At the conference, excepting the Reale Accademia dei Lincei, which was unable to send delegates, although in full sympathy with the movement, all the bodies invited were represented—the Berlin Academy by Messrs. Auwers, Virchow, and Diels; the Göttingen Society by Messrs. Ehlers and Leo; the Leipzig Society by Messrs. Windisch and Wislicenus; the Royal Society by Messrs. Rücker, Armstrong, and Schuster; the Munich Academy by Messrs. von Zittel, Dyck and von Sicherer; the Paris Academy by Messrs. Darboux and Moissan; the St. Petersburg Academy by Messrs. Famintzine and Salemann; the Washington Academy by Messrs. Newcomb, Remsen, and Bowditch; and the Vienna Academy by Messrs. Mussafia, von Lang, Lieben, and Gomperz.

*From the London *Times*.

Professor Auwers one of the secretaries of the Berlin Academy, occupied the chair, and the success of the meeting was largely due to the extreme ability and tact, combined with judicious firmness, with which he conducted the proceedings. Besides showing himself a master of the three languages—German, French and English—used in the debates, he was thoroughly informed on every point which came up for discussion. Fortunately, all the delegates appeared to be actuated by the desire to coöperate, and there was little difficulty in framing statutes which all were prepared to accept.

The immediate outcome of the conference has been that it is resolved to found an international union of the principal scientific and literary bodies of the world, the object of which will be to initiate or promote scientific enterprises of general interest recommended by one or more of the associated bodies, and to facilitate scientific intercourse between different countries. It is to be known as the International Association of Academies. A number of important bodies besides those represented at Wiesbaden are to be invited to join. General meetings of delegates from the various constituent academies are to take place, as a rule, at intervals of three years, but the interval may be varied and special meetings held, if necessary. The Royal Society had proposed, prior to the conference, that the first general meeting should be held in Paris next year. At the general meetings two sections will be constituted, one dealing with mathematics and the natural sciences, the other with arts and philosophy.

A council is to be appointed which will carry on the business in the intervals between meetings. The formation of committees of experts to initiate and promote scientific investigations of international importance is also contemplated.

It remains to be mentioned that the Berlin Academy had also arranged for the entertainment of the delegates at the close of the debates. On the Monday evening they were invited to attend a performance of Lortzing's opera *Undine*, and on the Tuesday they were entertained at dinner in the Kurhaus. On the latter occasion Professor Virchow occupied the chair, and opened the proceedings by toasting the delegates generally; he was followed by Professor Darboux, of Paris, who proposed the health of the Berlin Academy, and in the course of the evening numerous other toasts were proposed by the delegates.

SCIENTIFIC BOOKS.

The Kinetic Theory of Gases. By S. H. BURBURY. Cambridge University Press. 1899. Pp. 157.

Mr. Burbury has long been known as an occasional contributor to the Kinetic Theory of Gases. The first edition of Watson's treatise on this subject, published in 1876, acknowledged the indebtedness of its author to him; and in that very interesting discussion of the Kinetic Theory which was begun at the Oxford meeting of the British Association in 1894 and continued for months afterwards in *Nature*, Mr. Burbury took a conspicuous part, appearing as the expounder and defender of Boltzmann's H-theorem in answer to the question which so many have asked in secret, and which Mr. Culverwell asked in print, '*What is the H-theorem and what does it prove*'? Thanks to this discussion, to the more recent publication of Boltzmann's *Vorlesungen über Gas-theorie*, and finally to this treatise by Burbury, this question is not so difficult to answer as it was a few years ago; but it is probable that some readers of SCIENCE, even to this day, know less about the H-theorem than is contained in the following sketch of its history, which will serve to bring out one of the most interesting features of the book before us:

In 1860 Maxwell deduced from the laws of probability an expression for the final distribution of components of velocity among the particles of a gas consisting of very small elastic spheres having no action upon each other ex-

cept at the instants of collision. Many ingenious minds have since occupied themselves with this problem; and many discussions of it have been published with the purpose of improving upon the work of Maxwell, though none, so far as the reviewer is aware, has reached, for the case of a much rarefied gas, a different result. The especial defect of Maxwell's argument is his failure to show that the condition which he arrives at as the final condition of the gas is a necessary state, although he has shown it to be a possible state. Boltzmann especially has undertaken to supply what was lacking in the demonstration of Maxwell. Starting with a gas which has not yet reached its condition of 'stationary motion,' and in which the particles influence each other only at impact, he made a very particular study of the possibilities and results of collisions, with the purpose of showing that these results would as a whole tend to bring about the state of Maxwellian distribution of velocities, which would therefore be a necessary and final state. As an indispensable part of his argument he framed and used the so-called *H-theorem.* To attempt here a definite statement of this theorem would be folly. Let it suffice that H is a function based upon the laws of probability and that, according to Boltzmann, it necessarily decreases, through collisions, with lapse of time and by its diminution marks the progress of the gas towards the Maxwellian state, which is attained when H becomes a minimum. But critics have objected, Why must the H function diminish? If we imagine the velocity of every particle of the gas reversed at any instant, the H function ought to increase. Are not the reverse velocities as probable as those you imagine? And should not the net effect of all collisions be to leave H unchanged? To this Boltzmann replied that reverse velocities would indeed cause H to increase; but he urged that it was not allowable to imagine every velocity reversed. For example, in a case where a partial mixture of gases has come about by interdiffusion, a reversal of all velocities would cause the gases to separate from each other. This was an admirable and enlightening reply to the doubt raised, but the discussion is so beset with difficulties and possible obscurities that Mr. Burbury has done students good service in examining with much care a fundamental assumption upon which the argument of Boltzmann is based. Burbury's statement of this 'assumption A' is as follows:

"The chance of any molecule having velocity in x between u and $u + du$ is independent, not only of its position in space, but also of the v, w, which it has in directions y and z, and further except in the case mentioned below, it is independent of the positions and velocities at the instant of all the other molecules of the system. The excepted case is when the two molecules are so placed that they are, or very recently have been, within one another's sphere of action. The force of this exception, and the necessity for it, will appear in the consideration of the H-theorem."

Some of the most salient facts of the situation are these:

1. Boltzmann in preparing his H-theorem treats the number of pairs of particles which are *on the point of colliding*, at given velocities and angles, as a function of these velocities and angles and of these alone; but he treats the number of pairs which are *just parting from each other* at the same velocities and angles as a function of the pre-collision velocities and angles of the now separating pairs, on the ground that their number is determined by the number of pairs which an instant before were on the point of colliding with each other at certain velocities and angles alone capable of producing the post-collision velocities and angles mentioned. This is a matter of principle, not merely of convenience; for if particles just about to collide and particles just parting were numbered by like functions of velocities and angles, the number of particles leaving any class would be exactly equal to the number entering it, and there would be no H-theorem.

2. The function which expresses the number of particles having velocities lying within certain limits becomes the Maxwellian function when H has reached a minimum; and when this state is attained the exception noted in assumption A disappears.

The close scrutiny of assumptions is characteristic of Burbury's book. The fact that he has

named the statement above *assumption A* shows that he has in mind an assumption B. This latter, however, he does not attribute to Boltzmann. It is his own, and is of a character to show that he is entirely undismayed by the difficulties of the Kinetic Theory in its ordinary form. Assumption B is proposed as a substitute for assumption A, and it runs as follows:

"The chance of a given molecule having at any instant assigned velocities is *not* independent of the positions and velocities of all the other molecules at the instant. On this assumption B, instead of deducing the chance of the members of a group of n molecules having respectively at any instant the velocities $u_1 \cdots u_1 + du_1$, etc., from the assumed chances for individual molecules, we must reverse the process." According to this assumption "the chance that the x velocity of the first molecule shall lie between u_1 and $u_1 + du_1$, whatever be the positions and velocities of the other $n - 1$ molecules, is

$$\iint\int_{-\infty}^{+\infty}(dx_1dx_2 \cdots dz_n\, dv_1dw_1du_2 \cdots dw_n) \times F(x_1y_1 \cdots u_1 \cdots w_n)."$$

He does not introduce this complication out of pure wantonness, nor is he in this particular case making an effort to get, in his own phrase, 'as near an approach to chaos as is possible in an imperfect world.' It is his hope by means of assumption B so to generalize the Kinetic Theory as to make it fit the case of a vapor approaching liquefaction. A few quotations will indicate some of the aims and results of his discussion. Thus on p. 46 under the heading *Finite Forces*, by which phrase he means to exclude the case of 'rigid elastic bodies,' which exert infinite force upon each other at collision, he writes, "I propose to prove in this and the next chapter that in a system consisting of molecules of finite dimensions in stationary motion, it is not true for molecules very near to one another, that the chances of their having velocities between assigned limits are independent, as condition A assumes; but, on the contrary, if the forces be repulsive, they tend to move on the average in the same direction," etc.

In § 99, under the heading 'Concerning the Maxwell-Boltzmann Law $m_1\bar{a}_1^2 = m_2\bar{a}_2^2 =$ etc.,' that is, the law which asserts that the mean kinetic energy of the molecules of one species of particles is equal to that of the molecules of any other species at the same temperature, we have, "It seems therefore to follow that the law $m_1\bar{a}_1^2 = m_2\bar{a}_2^2$, etc., cannot hold universally. It can be accepted only on the authority of the great physicists by whose name it is known."

In § 107, "It follows from this result that" * * * "the system would tend more and more, with increasing number of molecules in a given space, to assume the form of a number of denser aggregates, say clouds, moving through a comparatively rare medium." On p. 112, after a passage similar to that just quoted, but containing other particulars, we have "Such is the process which our analysis leads us to expect. Physicists may consider how far it corresponds with what is known to take place in gases under condensation, or on what (if any) farther hypothesis it may be made to correspond with it." This last quotation is especially significant as to the point of view from which the whole book is written.

The last chapter (X.) is devoted to *Thermodynamical Relations*. It contains, with considerable matter descriptive of the speculations of others, the author's kinetic 'proof of the second law' of thermodynamics in accordance with 'assumption B.' His proof with assumption A was published in 1876, and Mr. G. H. Bryan,* who has made an exhaustive study of such efforts, declares it to be the simplest proof based on the 'Boltzmann-Maxwell law of distribution of speed.' But the wayfaring physicist who is seeking an excuse for avoiding an encounter with the new and more general proof offered by Mr. Burbury will find it in another remark made by Mr. Bryan in the conclusion of his report.† "Although many of the researches mentioned in this report are not infrequently called dynamical proofs of the Second Law, yet to prove the Second Law, about which we know something, by means of molecules, about which we know much less, would not be in consonance with the sentiments [judge the unknown from the known] expressed at the end of the last paragraph. The most conclusive evidence for regarding Carnot's principle

* B. A. Report, 1891, p. 85.

† Idem, p. 121.

as a theorem in molecular dynamics lies in the remarkable agreement between the results obtained by the methods described in the three different sections of this report, all of which are based on different fundamental hypotheses.''

EDWIN H. HALL.

CAMBRIDGE, October 28, 1899.

Elementi di calcolo infinitesimale con numerose applicazione geometriche. Per ERNESTO CESÀRO, professore ordinario della R. Universita di Napoli. Naples, Lorenzo Alvano. 1899. 8vo. Pp. 400.

The absence of a text-book on the calculus from a too well-known series of American mathematical text-books was recently remarked. The omission was excused by the observation that the author of the series knew nothing about the calculus. It might have been well for the cause of secondary and superior mathematical education in this country had the same modest confession been called into execution earlier and prevented the construction of the patch-work, fragmentary, stereotyped algebra of the same series. Contrast the confession of the razor-maker with the refusal made lately by a mathematician who declined to prepare an elementary treatise on the infinitesimal calculus on the ground that he knew too little arithmetic and algebra.

Cesàro had the courage to learn and make his mathematics before he began to publish any of his courses. His treatise* on algebraical analysis appeared five years ago and was most favorably received, although published against the advice of his friends. This work naturally contained an introduction to the infinitesimal calculus which gave full promise of the superb treatise which comes from the press this year. The former, which is by no means so finished a work of art as the latter, is a collection of sixty lectures on substitutions and determinants, linear forms, quadratic forms, irrational numbers, limits, series, functions, developments in series, complex numbers, quaternions, elimination, symmetric functions, enumeration of roots, numeric and algebraic resolution of equations, differences and interpolation, and factorial developments.

*Cesàro, Corso di Analisi algebrica con introduzione al Calcolo infinitesimale, Turin, Bocca, 1894.

Cesàro's course in the calculus is designed after the following plan the style of whose exposition is a most fortunate combination of mathematical rigor and poetic expression. There are three grand divisions occupied in order with fundamental theories, the differential calculus, and the integral calculus. The first of these consists of four chapters devoted to functions, derivatives, developments in series, and functions of several variables; the second part also contains four chapters presenting the theory of differentiation and its applications to the theories of plane curves, space curves and surfaces; the last division comprises five chapters on integration, applications to the evaluation of certain remarkable classes of integrals, applications to geometrical mensuration, differential equations and variations.

The reviewer has space to analyze but few of the chapters of this valuable work. The first chapter exhibits the principal properties of functions in all their modern refinement by the evolution of the following theorems: 1° If a function is finite throughout an interval it always admits of an inferior limit and a superior limit; 2° If a function is finite for all the numbers of an interval it is finite throughout the interval; 3° The first theorem of Weierstrass, if a function is finite in a finite interval, the latter contains at least one number for which the function has the same limits, inferior and superior, as the interval itself; 4° For the existence of a finite limit of $f(x)$ to the right of a it is sufficient that, given ε positive and as small as we wish, there can always be found a positive number h, such that, for every pair of values x' and x'' taken within the interval $(a, a+h)$, excluding the inferior limit, the absolute value of $f(x') - f(x'')$ is less than ε; 5° If $f(x)$ is continuous and different from zero for $x = a$, it possesses at a the sign of $f(a)$; 6° If a function is continuous in an interval it is also finite in the interval; 7° A function continuous in an interval at the extremities of which it takes opposite signs must vanish at least once in the interval; 8° A continuous function cannot pass from one value to another without passing through all the intermediate values; 9° Second theorem of Weierstrass, every function continuous in a finite interval takes the maximum and minimum value

in the same interval; 10° Cantor's theorem, if a function is continuous in a finite interval, we can determine for every positive number ε as small as we wish, a number h, such that in any interval of magnitude h contained within the given interval, the oscillation of the function shall be less than ε.

The second chapter deduces by the method of limits the rules of derivation of standard functions, together with the properties of derived functions, and concludes with the complements of the theory of limits introduced in the first chapter. The third chapter devoted to series discusses in order the convergence criteria, the Taylor-Maclaurin formula, the asymptotic evaluation of power-series, the technical discussion of functions, the interpolation formula and the decomposition of rational functions into sums of simple fractions. The notions of the first chapter are extended to functions of more than one variable in the fourth chapter, with special reference to the problems of maxima and minima. The examples and exercises of these chapters, most of which are resolved in full, are especially valuable; the collection of classic ones of derivativeless functions calls for remark; the character of these exercises is well exemplified by the following which are given in illustration of the theory of maxima and minima: 1° Calculate the lengths of the axes of the general conic; 2° Determine the lengths of the axes of the section of an ellipsoid made by a given diametral plane; 3° Find the minimum distance between two right lines; 4° Seek the minimum value of the sum of the squares of n variables connected by $m < n$ linear equations; 5° The method of least squares.

In this day of multiple algebras and multiple geometries it is not surprising to find Cesàro proposing multiplications of the differential calculus. These observations form an interesting section of the fifth chapter which gives the ordinary methods for the differentiation of explicit and implicit functions of one or several variables. The differential dx of the independant variable, arbitrary for each value of x, Cesàro considers as the product of an infinitesimal α independent of x by an arbitrary function of x, *i. e.*, $dx = \alpha\chi(x)$. Differentiating this expression we have

$$d^2x = d\alpha\chi = \alpha d\chi = \alpha\chi' dx = \alpha^2\chi\chi',$$
$$d^3x = \alpha^3(\chi\chi'^2 + \chi^2\chi''),$$
$$d^4x = \alpha^4(\chi\chi'^3 + 4\chi^2\chi'\chi'' + \chi^3\chi'''), \cdots$$

The results of these successive differentiations become rapidly more complicated, and would as rapidly rob the calculus of most of its advantages if the function χ be allowed to retain its arbitrary character. For convenience $\chi(x)$ is made equal unity and we have $d^2x = d^3x = \cdots = 0$, which expresses that x is equicrescent, *i. e.*, that the differential of the independent variable is independent of the variable. However it is only necessary to call in the fundamental principle of the integral calculus to show that every form of calculus resulting from a change of form in the function χ reduces to the ordinary calculus; the reduction is effected in precisely the same manner that a change of independent variable is made. Thus, there is always a function t of x whose derivative is $1 : \chi(x)$, then

$$dt = t'dx = \frac{1}{\chi(x)} \cdot \alpha\chi(x) = \alpha, \quad d^2t = d^3t = \cdots = 0.$$

The possibility of a calculus in which no variable possesses a constant differential is not excluded, but it is certain that the simplicity and homogeneity of its formulæ and the precision with which the ordinary calculus assigns the orders of its infinitesimals will not be among the advantages of the new calculus.

It may be remarked here in passing that a Norwegian mathematician attempted a few years ago to found a new calculus, in which the fundamental rôle taken by addition and subtraction in the ordinary calculus was assigned to the operations of multiplication and division. The resulting forms yielded certain continued products, but were otherwise fruitless.

The sixth and seventh chapters contain the geometrical applications to plane and space curves. These chapters must have offered a sore temptatation to the author to make exclusive use of his own elegant method of intrinsic analysis, but the reader finds no method employed to the exclusion of all others. The applications follow the usual order of tangents, normals, curvature, asymptotes, singularities, contacts, and envelopes. The examples are happily chosen, and the chapters amply illustrated with well executed figures.

The elements of the theory of surfaces are introduced in the eighth chapter and applied to ruled surfaces and envelopes. The theory of curvature is elaborated in detail, including the notions of mean curvature due to Germain, total curvature conceived by Gauss, and quadratic curvature of Casorati. The chapter concludes with the determination and properties of the remarkable lines of a surface.

The ninth chapter begins the study of the inverse problems by presenting the fundamental concepts and rules of simple and multiple integration. The tenth chapter evaluates the well-known forms of rational, irrational and transcendental indefinite integrals, and terminates with certain classes of definite integrals, including elliptic and eulerian integrals; the nature of the example is indicated by the following, which occurs in the study of vortices:

$$\frac{ab}{2\pi}\int^{2\pi}\frac{\cos\theta d\theta}{\sqrt{a^2+b^2+c^2-2ab\cos\theta}}.$$

After making the ordinary applications to mensuration in the eleventh chapter, the author undertakes the elements of the theory of differential equations in the twelfth chapter. The distinctions between the notions general, particular, and singular integral are clearly made. The cases of integrable ordinary differential equations are classified as follows: 1° variables separable; 2° functions homogeneous; 3° one variable absent; 4° second order equation lacking one variable always reducible to one of first order; 5° linear equation; 6° Bernouilli's equation; 7° Clairaut's equation; 8° the form $y = x\phi(y') + \psi(y')$, when not a Clairaut equation is reducible to a linear equation; 9° Riccati's equation and its characteristic property that the anharmonic ratio of any four particular integrals is constant. No reference is made to Lie's theories. A well selected list of resolved problems is followed by geometrical applications of differential equations to plane curves, trajectories and surfaces. The general linear equation and equations with constant coefficients are studied somewhat *in extenso*. Passing then to equations in more than two variables, the author takes up total differential equations and simultaneous ordinary equations and terminates the chapter with a short treatment of the partial differential equation.

The last chapter of the book gives the elementary notions of the calculus of variations in six pages. The volume concludes with notes on the concept of limit, oscillatory extremes, demonstration of Cantor's theorem, Hadamard's theorem, minima and maxima of functions, cusps and flexions at a pole, torsion of curves, calculation of the curvature of a surface, formulæ of Rodrigues, general formula of Stirling.

E. O. LOVETT.

PRINCETON, NEW JERSEY.

Pflanzen- und Tierverbreitung, in Hann, Hochstetter und Pokomy, Algemeine Erdkunde. By A. KIRCHHOFF. Verlag, F. Tempsky, Wien. Aufl. 5. 1899.

This volume, by Alfred Kirchhoff, forms the third part of the new edition of a well-known and compendious manual of pure as distinguished from economic geography. It maintains the high standard of the preceding parts by Hann and by Brückner, and is a welcome addition to the literature of geo-biology. Of the 157 figures, a large proportion are not easily accessible elsewhere or are quite new. The maps, while not emphasizing the developmental phases of faunal and floral distribution as do, for example, those of Engler, are, nevertheless, more nearly in accord with modern ideas than those of Grisebach or Decandolle. The ecological factors are, by no means, neglected, as they were so generally in the older books. While it is true that they are scarcely so exhaustively discussed and laboriously analyzed as in the special treatises of Warming and Schimper, yet they are clearly, ably and adequately presented. Kirchhoff's work, has a certain advantage over the special *Tierlebens* and *Pflanzen-geographies* in its broad outlook upon both the fields of biological science. It falls naturally enough into three divisions, the first including the general discussion of the relations between the earth and the organisms that inhabit it, the second comprising the analysis of floral, and the third that of faunal regions. The peculiar excellence of the treatment is apparent at once in the opening chapters on the migrations of organisms, on the environmental conditions

of plants and animals, on the modifications and hereditary distribution, and particularly, perhaps, in the very admirable fifth chapter of the first part which, under the title of 'elements of plant and animal distribution' gives precisely the catholic and panoramic view of geographical distribution that must be regarded as most desirable. Here are included with much wealth of illustration and judgment as to detail, accounts of the distribution of species, both plant and animal, of genera and of families and orders. Statistics of distribution, physiognomic and climatic groups, plant and animal zones, domesticated plants and animals and colonial aggregates are skilfully compiled and made the basis for useful generalization.

The second chapter, that dealing with floral regions, reminds one upon the whole of the Grisebachian discussion, though somewhat tempered by recent research. It is scarcely abreast, however, of the work of Drude and a list of the *Florenreichen* will show that the tone, on the whole, is analytic rather than synthetic. They are as follows: Northern, Mediterranean, Turanian, East Asian, Indian, tropical African, South African, tropical American, extra tropical South American, Australian, New Zealandian, Polynesian, Oceanic, making in all thirteen principal floral divisions of the earth. The omission of an Antarctic region seems scarcely to be justified. The principal regions of faunal distributions are slightly different and are added here for comparison. They are: North-polar, Northern, Eurasian, Mediterranean, Turanian, Indian, Trans-Saharan, Madagascaran, North American, tropical American, Andian-Argentine, West Indian, Australian, Papuan, New Zealandian, Polynesian and Oceanic, making in all seventeen principal faunal regions. That the divisions for plants and animals correspond so generally is impressively indicated by these classifications. Minor differences, however, exist and indicate the rather stronger climatic influence upon the stationary plants and the relatively stronger influence of insular isolation upon the locomotive animals. Thus Papuan, West Indian and Madagascaran divisions are necessary in the classification of animal groups, but not in that of plant societies. Again, North America, exclusive of the polar regions, becomes a single province for animals, while for plants it is divided into two upon a basis of climate.

A quite insufficient index closes the volume, and it is to be regretted that its stores of useful and sometimes elaborate information are not made more easily accessible.

CONWAY MACMILLAN.

Sewage-Analysis. By J. ALFRED WANKLYN and WILLIAM JOHN COOPER. A practical treatise on the examination of sewage and affluents from sewage. Including also a chapter on Utilization and Purification of Sewage. Philadelphia, J. B. Lippincott Company. 1899. Pp. xvi + 220.

The first eighty-two pages are devoted to analytical processes not essentially different from those published in 'Wanklyn's Water Analysis,' and in view of the fact that polluted water and sewage differ but in degree of pollution, it is reasonable to doubt the necessity of repeating information such as this to those already familiar with water methods.

One must always open with respect a book bearing the name of 'Wanklyn,' but in these days of active and accurate water investigation it would seem that the author of the 'Albuminoid Ammonia Process' has hardly kept in touch with what advances have been made by those who would be glad to be accounted his pupils. Thus the old writing paper packing for the retort neck is yet retained in the treatise under consideration; and a confidence is reposed in the 'goodness' of 'good tap-water' for final rinsing, which many water-analysts know to be misplaced. Much space has been given to criticisms of methods of which the authors do not approve, and the style of such criticism suggests the old acrimonious discussion of some years ago.

It is most unfortunate that the authors should have seen fit to refer to the oxidation of organic compounds through the action of germ life as 'a fashionable fad and delusion of the day'; nor is it seemly to announce that "neither is the burning of the kitchen-fire nor the action of the steam-engine a manifestation of bacterial action."

Such remarks strike the reader as unworthy

of men of repute. Under the section dealing with sewage purification, there is no mention whatever of the work done by the Massachusetts Board of Health.

The appendix is voluminous and consists largely of extracts from previous papers published by the authors during the years 1866 to 1891.
W. P. MASON.

Laboratory Manual, Experiments to Illustrate the Elementary Principles of Chemistry. By H. W. HILLYER, PH.D., Assistant Professor of Organic Chemistry in the University of Wisconsin. New York, The Macmillan Company. 1899. Pp. vi+200. Price, 90 cents.

After a short chapter on manipulation, this manual is divided into two parts. Part I. is given to the preparation and properties of the elements and their compounds. The usual illustrative experiments are given, all of these being of a purely qualitative character. A few problems for calculation are, however, inserted. Part II. is devoted to the verification of quantitative laws, especially the laws of constant and multiple proportion, the laws of combination for gases, and vapor densities. Very much, of course, depends on the teacher, but there seems to be some danger that the work of many students with the first part of this book will degenerate into merely playing with chemicals. The old method of preparing stannic chloride given on page 144 might, with advantage, be replaced by that of Lorenz, (Zeit. f. Anorg. Ch. 10, 44.).

Inorganic Chemical Preparations. By FELIX LENGFELD, Assistant Professor of Inorganic Chemistry in the University of Chicago. New York, The Macmillan Company. 1899. Pp. xviii+57. Price, 60 cents.

The study of inorganic chemical preparations deserves a much larger place than has usually been assigned to the subject in chemical courses. The selection of topics in Dr. Lengfeld's book is excellent. Some of the directions are, perhaps, a little too concise for the use of students who have not had a good deal of laboratory experience. Without close watching many students would certainly fall into serious mistakes—but, then, a student often learns more from a mistake than by doing a thing right the first time.
W. A. NOYES.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for November contains the following articles:

'Types of March Weather in the United States,' by O. L. Fassig.

'Some new Minerals from the Zinc Mines at Franklin, N. J., and Note concerning the Chemical Composition of Ganomalite,' by S. L. Penfield and C. H. Warren.

'Action of Acetylene on the Oxides of Copper,' by F. A. Gooch and DeF. Baldwin.

'Andesites of the Aroostock Volcanic Area of Maine,' by H. E. Gregory.

'New mode of occurrence of Ruby in North Carolina,' by J. W. Judd and W. E. Hidden. With Crystallographic Notes by J. H. Pratt.

The Osprey for October, makes its appearance under new editors and is a particularly good number, being very strong in interesting notes. The first article, 'The Home of a Pair of Wood Thrushes' is by R. W. Johnson; then follow 'The Butcher Bird in Florida,' by Mrs. M. A. Ohlinger; 'Peculiar Nesting of the Hooded Merganser,' by Glen Rinker; 'Robin Recitals and Variations,' by P. M. Silloway, and 'Nesting of the Bald Eagle,' by Wm. H. Fisher. The principal article, 'Wild Guinea-Fowl of Barbuda,' by Frederick A. Ober, is in that writer's best vein. L. A. Fuertes notes the occurrence of 'Two Rare Warblers at Ithaca.' In the correspondence Mr. J. Parker Norris replies to his critics in a letter on 'The Utility of Large Series of Eggs.'

Appleton's Popular Science Monthly, for November, contains a portrait and sketch of Dr. George M. Sternberg, Surgeon-General, U. S. A. The number also contains an article on Cambridge University by Mr. Herbert Stotesbury with portraits of Sir Michael Foster, Professors J. J. Thomson, G. H. Darwin, Henry Sidgwick and James Ward, Dr. Donald Macalister and Sir George Stokes. Other articles are on 'Wireless Telegraphy,' by Professor John Trowbridge; 'Emigrant Diamonds in America,' by Dr. Wm. H. Hobbs; 'On Spider Bites' and 'Kissing Bugs,' by Dr. L. O. Howard, and a review of Wallace's 'Wonderful Century,' by Professor W. K. Brooks.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, October 28th. Thirty-one persons attended the two sessions, and twelve papers were presented. Immediately at the opening of the morning session a recess was taken to enable the members to hear the Presidential Address of Professor Rowland before the American Physical Society, which met in the same building. The simultaneous meeting of the two societies naturally resulted in a reinforcement of interest and activity, and it is hoped that this and other coöperative action may become the established order.

It has been arranged with a view to economy of time that hereafter the morning session of the meetings of the Society shall open at 11 o'clock, and the afternoon session at 2 o'clock. The Council will meet at 10:15 A. M.

The Editorial Board announced that the arrangements for publishing the *Transactions*, the newly created organ of the Society, were in a most favorable state of progress. The first number will appear January 1, 1900. The fact that two first-class journals are not only possible but actually required for the publication of the mathematical output of this country is a striking evidence of the growth of the science here in the last few years.

The following persons were elected to membership in the Society:

Professor M. E. Bogarte, Northern Indiana Normal School, Valparaiso, Ind.; Mr. A. S. Gale, Yale University; Mr. B. L. Groat, University of Minnesota; Dr. Edward Kasner, Columbia University; Professor J. A. Miller, University of Indiana; Professor A. M. Sawin, Clark University, Atlanta, Ga.; Professor S. A. Singer, Capital University, Columbus, Ohio; Dr. H. E. Slaught, University of Chicago; Professor E. P. Thompson, Miami University, Oxford, Ohio. Seven applications for membership were received.

The following papers were read:

(1) Professor PAUL GORDAN: 'Formentheoretische Entwickelung der in Herrn White's Abhandlung über Curven dritter Ordnung enthaltenen Sätze.'

(2) Professor E. O. LOVETT: 'The transformation of straight lines into spheres.'

(3) Dr. G. A. MILLER: 'On the simply transitive primitive groups.'

(4) Professor CHARLOTTE ANGAS SCOTT: 'The conditions imposed on a curve by assigned multiple points.'

(5) Professor E. H. MOORE: 'On the generational determination of abstract groups' (preliminary communication).

(6) Professor CHARLOTTE ANGAS SCOTT: 'The status of imaginaries in pure geometry.'

(7) Professor MAXIME BÔCHER: 'On Sturm's theorem of comparison' (preliminary communication).

(8) Professor F. MORLEY: 'On a fundamental geometric construction.'

(9) Mr. E. B. WILSON: 'The decomposition of the general collineation of space into three skew reflections.'

(10) Dr. G. A. MILLER: 'On the order of the product of two substitutions.'

(11) Mr. J. K. WHITTEMORE: 'On a generalization of the fundamental problem of the calculus of variation.'

(12) Mr. J. L. COOLIDGE: 'A projective representation of the imaginary points of a plane.'

The next meeting of the Society, which will be held on Thursday, December 28th, will be the annual meeting for the election of officers. The Chicago Section will meet at the University of Chicago on Thursday and Friday, December 28–9. At the annual meeting President Woodward will deliver a Presidential Address on 'The Century's Progress in Applied Mathematics.'

F. N. COLE,
Secretary.

TORREY BOTANICAL CLUB.

AT the meeting on October 10, 1899, nine new members were elected.

A series of nature-printed plant-plates was exhibited by Monsieur Alois Barta, temporarily at 521 East 82d Street, including algæ and phanerogams, all printed in natural colors. They excited great interest on account of their beauty and slight expense.

Dr. MacDougal referred to the success of the Sullivant Day at the Columbus meeting of the

American Association for the Advancement of Science this last August, one of the most interesting features of the meeting, and a tribute to the careful plans prepared for it by Mrs. E. G. Britton.

The remainder of the evening was devoted to reports from excursions and from summer observations by members.

Dr. Rusby, as guide to nine excursions in the spring, reported an average attendance of 31.

Menispermum rhizomes, as examined at Upper Mountain, N. J., April 8th, had begun no new growth and were still connected with the frost-killed stems, the point of change from rhizome to stem being purely an accidental result of exposure. The plant being essentially tropical, acts toward killing frost as if but imperfectly habituated to it.

Obolaria was well-developed this day, perhaps the earliest spring flower of its locality.

Professor Underwood reported on field work in July, and upon the Decoration Day excursion to Tullytown, Pa., about 20 persons from Philadelphia and 12 from New York present. *Isoetes riparis*, a tidal plant, occurred along tributary rivers.

Dr. Britton reported on the Fourth of July excursion to the Delaware River at Bull's Island, another *Isoetes*, *I. Dodgii*, occurring there.

Professor T. C. Porter reported the occurrence of *Equisetum littorale*, *Onosmodium Virgianum*, etc., at the Bull's Island locality.

Both of these excursions were contributory to Dr. Bretts' revision of Dr. Meyer's excellent catalogue of the Bucks county flora, soon to be issued. It is now being worked out with attention to details of distribution, ecology and modern taxonomic views. If we could have other counties here in the east worked up in a similar critical way, it would be a great aid to science.

Discussions regarding various Gentians followed.

Mr. Van Brunt reported seeing a single stem bearing 59 flowers of *Gentiana crinita*; all the upper, certainly 20, in full bloom. Putting the plants, after clipping, in the dark over night, and till 9 or 10 a. m., they expanded beautifully on exposure to the light.

Rev. L. T. Chamberlain reported 96 buds and blossoms on a single stem of *Gentiana crinita* in Massachusetts at West Brookfield. White blossoms came out in six weeks, the stem having bloomed in his study 42 days. Mr. Chamberlain also reported that Mr. Isaac Lea, of Philadelphia, had told him of finding a stem of *Gentiana crinita* with 150 blossoms.

Professor Porter called attention to white flowers of *G. Andrewsii;* it is this, he thinks, which was described as *G. alba.*

Mrs. Britton reported *G. quinqueflora* two or three feet high, and Professor Porter spoke of the habit of this plant to produce a great variety of size in the same soil, with little dwarfs with one flower at one inch high.

Professor Porter spoke of *G. flavida* as recently found in Bucks county.

Dr. Rusby referred to a successful experiment in scattering the seeds of the Fringed Gentians upon the snow, resulting in a profusion of young seedlings.

Mr. S. Henshaw paid a tribute to the beauty of the Alpine Gentians of the Old World.

EDWARD S. BURGESS,
Secretary

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE Science Club of the University of Wisconsin held its first meeting of the year on October 24th, with Mr. Charles R. Van Hise, the newly elected President, in the chair.

The programme of the evening consisted of the following papers:

'Earth Movements in the Pomperang Valley,' Connecticut, by Wm. H. Hobbs; 'Some Recent Observations Upon the Change of Length of Iron Due to Magnetization, by L. W. Austin.

The first paper was a study of block faulting in the Newark Formation of the Pomperang Valley, an area of fifty square miles in western Connecticut. It was illustrated by a large number of lantern slides.

Mr. Austin gave the results of his recent work on the change of length of iron in an alternating magnetic field. He finds that when iron is magnetized by means of an alternating current, the expansion is less than with a direct

current, and that this decrease becomes greater as the frequency becomes higher. There is a marked analogy between this phenomenon and the decrease in the magnetic permeability in an alternating magnetic field as the frequency is increased, a fact which has been recently established by Niethammer and M. Wien.

WM. H. HOBBS.

DISCUSSION AND CORRESPONDENCE.

GEOLOGICAL TIME.

EDITOR OF SCIENCE: Sir Archibald Geikie's recent forcible plea to working geologists for the more careful accumulation of data which may yield reliable estimates of geological time, makes the interesting suggestion given in SCIENCE, October 27th, by Professor Wilbur C. Knight, under the title of 'Some New Data for Converting Geological Time Into Years,' seem very timely. The opportunities for making such calculations of the rate of retreat of cliffs under the action of subærial decay, by employing slow-growing trees on the escarpments as a chronometer, are far wider spread than at first thought might seem likely.

In justice to the maiden work of a now eminent American geologist, it is proper to recall the fact that the first suggestion of this method and its first practical application were made by Dr. G. K. Gilbert, in 1866, when temporarily connected with the staff of the New York State Museum. After the excavation of the mastodon skeleton now standing in the State Museum, from a glacial pot hole in the valley of the Mohawk river at Cohoes, N. Y., Mr. Gilbert gave attention to an estimate of the rate of retreat of the cliffs of the river gorge, basing his observations on the degree to which the roots of the red cedars on the banks had been exposed by the falling away of the rock face. Mr. Gilbert's observations and deductions were published in the 21st annual report on the New York State Cabinet of Natural History (1871), and I quote from them the following paragraph: "Climbing from below or lowered by a rope from above, I have examined nearly all these trees and measured in each case the circumference of trunk and length of exposed root. I have also counted the rings of annual accretion of several sections to ascertain the relation of size to age. From these data an idea may be obtained of the rate of recession of the cliff. The growth is exceedingly slow. A branch of one and one-eighth inch in diameter showed 100 rings of growth, and an average of six such branches gave 72 years per inch of diameter. The figures used below were obtained from two sections of trunks. One of these measures 19½ inches in circumference and exhibits 310 rings; the other gave 11 inches and 270 rings. In these an inch of circumference represents 19.1 years, and an inch of diameter, 60 years."

He then gives a tabulation of results derived from 19 of these ancient gnarled cedars and by dividing the average measured length of exposed root by the average estimated age of the tree, arrives at the figure 15.2 inches as the rate of retreat of the rock face per century. This figure for other considerations he reduced to 12 inches per century and upon this calculation bases his final statement: "This gives as the time necessary to have removed the banks below the fall [Cohoes] from the deep channel to their present position, 35,000 years, which period I consider a minimum for the time that has elapsed since Cohoes falls were opposite the mastodon pot hole."

Twenty years ago the writer applied the same method to a calculation of the rate of retreat of the shale escarpments along Canandaigua Lake, N. Y., where these ancient cedars were at that time abundant, and had the satisfaction of arriving at a conclusion very like that obtained by Mr. Gilbert. Just where the weakness in such calculations may lie is not at once evident unless there be one in admitting the *annual* value of the growth rings in the tree. Mr. Gilbert's method, now revived by Professor Knight, merits renewed and general application. Employed with caution and care to exclude diverse agencies of retreat, it ought to afford eventually, important conclusions.

JOHN M. CLARKE.

ALBANY, N. Y.

NEWSPAPER SCIENCE.

TO THE EDITOR OF SCIENCE: So much has been published far and wide this last summer about my intention 'to scientifically demon-

strate the immortality of the soul within a year,' that it is due to the facts bearing upon the choice between materialism and spiritism to say that I have never made any such professions as have been alleged. I wish to make this statement, because I shall leave no excuse in my report of my facts for judging of them from that point of view. Whether they have any value or not I do not care to say, as I am not the person to urge that view of them. I merely wish the scientific public that still has the bad habit of reading and believing the newspapers to know that I was careful to deny that I made any such pretensions as were so generally attributed to me. More than one-half the interviews alleged to have been held with me were the fabrications of reporters who never saw me, and the other half omitted what I did say and published what I did not say. There would be no reason to make this correction at all except that the wide currency given to a pretension that I never entertained creates a standard by which I am far from estimating the facts myself, and much less can I expect others to treat it with respect. It is true that I have reversed my preferences in the choice between spiritism and materialism on account of ten years study of the Piper case, but I have done so on grounds that must force respect, even when they do not produce conviction; and the only object I had in facing public scorn was to make it as respectable to study these phenomena as it is to investigate insanity and other abnormal facts. There is a perfectly inexcusable cowardice in the attitude of scientific men toward the claims of spiritualism, and they are treated with a contempt which men would be ashamed to exhibit toward the phenomena of insanity. Hence having a body of facts for which I can safely demand consideration on some theory, I have only thrown down the gauntlet to those who have not accepted telepathy and simply ask that they turn the balance in favor of that hypothesis, instead of the spiritistic for which I have merely declared a preference, but which I should be the first to surrender, if science establishes a preference for the infinite in a woman's skull. But what I shall have to report must not be estimated as an attempt to demonstrate anything even to myself, to say nothing of those who have neither studied the subject nor taken the pains to question the authority of respectability.

James H. Hyslop.
Columbia University,
New York.

NOTES ON ORGANIC CHEMISTRY.

In the usual methods of quantitative analysis by electrolysis, the cathode is usually a platinum cone or cylinder, giving greater current on the exterior than in the interior, and an unequal deposition of the metallic deposit. In Oettel's improvement a platinum plate is used as cathode, with a fork-shaped anode, one arm on each side of the cathode. This is only partially successful in overcoming the difficulties, the deposit tending especially to scale off. In the *Berichte*, Clemens Winkler suggests the use of platinum gauze as a kathode. The metal is deposited very regularly even with strong current. It is in the form of a cylinder around each thread of gauze, is compact, firmly deposited, and shows no tendency to scale off, even at very considerable current strength. The time required is only about one-fourth as great as with the old form of electrode. Many solutions are therefore available which could not otherwise be used, as, for example, copper is readily deposited in large quantities from its sulfate solution.

In the last number of the *Bulletin* of the French Chemical Society, Weisberg gives a large series of experiments as to the power of aqueous solutions of sugar to dissolve lime. The amount which can be thus dissolved is about 27 grams of lime per 100 grams of dissolved sugar. In solution with very little sugar the relative amount of lime taken up is larger than this, but the absolute amount is of course small. Previous observations are confirmed that lime in its anhydrous form, CaO, is more soluble in sugar solutions than is its form of calcium hydroxide or milk of lime.

Some time since the use of calcium carbid as a reducing substance for high temperatures was suggested by Warren. This subject has now been worked up by Tarrugi in the *Gazetta*, and he finds most metallic salts are decomposed

with great ease with the formation of calcium alloys, and, in a few cases, of the free metal. As this is the case with chromium, it may be possible to devise a commercial method for its manufacture by the use of calcium carbid.

SOME years ago the sterilization of water by chlorid of lime (bleaching powder) was suggested by Traube, and the subject was further studied by Bassenge. In a recent number of the *Hygienische Rundschau*, A. Lode, of Innsbruck, describes further experiments along the same line. The process, as practically carried out, demands 0.15 gram of commercial, dry chlorid of lime per liter of water to be purified. This is rubbed with an equal weight of water in a porcelain dish, or on a large scale in a suitable wooden or stone vessel, to a thin paste, and added with constant agitation to the water. The corresponding amount of hydrochloric acid, for which the author gives a table, is then added. In the course of half an hour the water has cleared and 0.3 grams of sodium sulfite per liter is added. The cost of the process is found to be about 8 cents per cubic meter of water. It is claimed that by this process the water is completely sterilized, and even very bad waters rendered potable.

J. L. H.

THE NOVEMBER METEORS OF 1899.

PROFESSOR E. C. PICKERING has sent from the Harvard College Observatory the following account of the approaching meteoric shower:

The predicted time of maximum of the November meteors is November 15, 1899, at 18 h. Greenwich mean time. As a similar shower may not occur again for thirty years, no pains should be spared to secure the best possible observations. The most useful observations that can be made by amateurs are those which will serve to determine the number of meteors visible per hour throughout the entire duration of the shower. They should be made on November 15th, and also on the two preceding and following evenings. The most important time for observation is from midnight until dawn, as comparatively few meteors are expected earlier. Observations are particularly needed at hours when they cannot be made at the observatories of Europe and America. In general, the time required for ten or more meteors to appear in the region covered by the accompanying map, should be recorded. This observation should be repeated every hour or half hour. If the meteors are too numerous to count all those appearing upon the map, the observer should confine his attention exclusively to some small region, such as that included between the stars μ Ursae Majoris, 40 Lyncis, δ and α Leonis. If the meteors occur but seldom, one every five minutes, for instance, the time and class of each meteor should be recorded. Also note the time during which the sky was watched and no meteors seen, and the time during which that portion of the sky was obscured by clouds. Passing clouds or haze, during the time of observation should also be recorded. The date should be the astronomical day, beginning at noon, that is, the date of early morning observations should be that of the preceding evening. Specify what time is used, as Greenwich, standard, or local time. When a meteor bursts, make a second observation of its light and color, and when it leaves a trail, record the motion of the latter by charting the neighboring stars, and sketching its position among them at short intervals until it disappears, noting the time of each observation. If the path of a meteor is surely curved, record it carefully upon the map.

On November 14, 1898, thirty-four photographs were obtained of eleven different meteors. Their discussion has led to results of unexpected value. The greatest number of meteors photographed by one instrument was five. Only two meteors were photographed which passed outside of the region covered by the map, although the total region covered was three or four times as great. No meteors fainter than the second magnitude were photographed.

Photographs may be taken, first, by leaving the camera at rest, when the image of the stars will trail over the plate and appear as lines, or secondly, attaching the camera to an equatorial telescope moved by clockwork, when a chart of the sky will be formed, in which the stars will appear as points. A rapid-rectilinear lens is to be preferred in the first case, a wide-angle lens in the second. The full aperture should be used and as large a plate as can be covered.

The most rapid plates are best for this work; they should be changed once an hour, and the exact times of starting and stopping recorded. Care should be taken to stiffen the camera by braces, so that the focus will not be changed when the instrument is pointed to different portions of the sky, especially if the lens is heavy. If the first method is employed, the position of the camera should be changed after each plate, so as to include as much as possible of the region of the map on each photograph. If pointed a little southeast of ε Leonis, the radiant will reach the center of the field about the middle of the exposure. A watch of the region should also be kept, and the exact time of appearance and path of each meteor as bright as the Pole Star should be recorded. The plates should be numbered on the film side with a pencil, and should be sent to the Harvard Observatory with accompanying notes and other observations. After measurement there, they will be returned if desired. The value of the results will be much increased if similar photographs can be obtained by a second camera from ten to forty miles distant, and preferably north or south of the other.

OBSERVATION OF THE TOTAL SOLAR ECLIPSE IN 1900.

PRESIDENT HARPER, of the University of Chicago, at the 30th Convocation of the University on October 2d, spoke as follows of plans for observing the approaching solar eclipse:

A total eclipse of the sun is regarded as an event of great importance by astronomers, because of the opportunity it affords for studying the solar corona and other phenomena which are invisible at other times. The last total eclipse visible in the United States occurred on July 1, 1889, and a great number of astronomers from the various observatories visited California for the purpose of making observations. The next total eclipse will occur on May 28, 1900, the path of the shadow extending through the States of Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi and Louisiana. Extensive preparations for observing it are being made by many institutions. General arrangements have been entrusted to an Eclipse Committee, of which the Director of the Yerkes Observatory is Secretary, appointed last year, at the Harvard Conference of Astronomers and Astrophysicists.

(1) Photographic observations of the spectrum of the sun's edge, similar to those made at the recent eclipses in India and Nova Zembla, but with more powerful apparatus.

(2) Photographs of the corona on a large scale, for the purpose of showing the detailed structure.

(3) Measurement of the heat radiation of the corona.

This last investigation has not been carried out successfully at any previous eclipse. Special instruments have been devised for the purpose, which promise to give interesting results. Professor Nichols, of Dartmouth College, who, in the summer of 1898, succeeded for the first time in detecting heat radiation from the stars, at the Yerkes Observatory, has offered to assist in making these measurements and expects to furnish part of the apparatus.

The Yerkes Observatory did not have the means to send an expedition to the last eclipse, which occurred in India in January, 1898. As the present occasion is so favorable, and as the expense involved is comparatively small, it is hoped that the friends of the observatory will make it possible to send out a party. The expenses will include a large heliostat, with accessory apparatus for determining the radiation of the corona and for photographing the corona on a large scale; transportation expenses for four astronomers, freight and express charges, teaming, lumber, brick, cement, labor, etc. (for the construction of temporary shelters for the instruments and piers). Other apparatus, including spectroscopes, telescopes, and all mirrors for the heliostat, etc., will be supplied from the Yerkes Observatory. The heliostat and other instruments to be purchased will become an important part of the permanent equipment of the observatory, to be used in its daily work on the sun.

On account of the exceptionally favorable atmospheric conditions which prevail at Lake Geneva during the day, special attention is given at the Yerkes Observatory to the study of the sun. A number of important advances in our

knowledge of the sun have recently been made here, and when the instrumental equipment now in process of construction has been completed, this observatory will be able to undertake more solar work than any other institution. It is, therefore, of special importance that a party should be sent from here to observe the eclipse of May 28, 1900 (probably to Georgia), particularly as the next total eclipse visible in the United States will not occur until 1918. As the work which has been planned for this party will require special instruments constructed for the occasion, the expense of the expedition will amount to about $3,000. It is proposed to undertake three special lines of work.

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN THE WEST INDIES.

WE have already given some account of the Imperial Department of Agriculture in the West Indies, established by the British Government, with Dr. Daniel Morris as Commissioner. The *Experiment Station Record*, quoting from the first number of the *West Indian Bulletin*, the official organ of the Department, gives an account of its work. In accordance with the recommendations of the West Indian Royal Commission, appointed in December, 1896, the British Government has appropriated £4,500 for the new department for the first year, and it is estimated that in future an annual grant of £17,500 will be required to carry out the recommendations of the Commission as adopted.

The headquarters of the department are at Barbadoes. Its duties are twofold: "(1) To endeavor to restore the sugar industry to a condition in which it can be profitably carried on, and (2) to encourage the establishment of other industries in such colonies as afford suitable conditions to supplement the staple industry."

Four 'principal' or 'central' experiment stations and eight 'local' stations for the improvement of the sugar cane will be established on the island of Barbadoes. The object of the central stations will be the growing of seedlings and improvement of varieties, and the carrying on of fertilizer experiments. The more promising varieties will be given a practical trial at the local stations to test their adaptability and value in different soils and localities, and also as a demonstration to the planters in each parish. Experiments on similar lines have been arranged for at Antigua and St. Kitts, while the work previously inaugurated at Trinidad will be largely extended and the necessary chemical assistance provided. The botanic stations placed under the control of the department are those at Tobago, Grenada, St. Vincent, Barbadoes, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts-Nevis. The object of these stations is to test and distribute promising economic plants for the region, introduce new or little-known plants for experimental cultivation, and conduct experiments on the improvements of sugar cane. In addition they distribute information, and send out lecturers for institute work.

It is also proposed to establish central sugar factories equipped with the best machinery, and it is the expectation of the department to establish one or two experimental factories at an early date. The plan of the Royal Commission to establish agricultural schools in connection with the botanic stations has been carried out by opening a school at Dominica, and others will be started at St. Vincent, St. Lucia and St. Kitts-Nevis as soon as the necessary land is obtained. Furthermore, the department is prepared to offer grants to enable certain institutions to employ teachers in agricultural science, and possibly to provide a number of scholarships and in coöperation with the central educational authorities in each colony, the teachers in the elementary schools will be given a course of instruction in the principles of agriculture, to enable them to give simple instruction and conduct school gardens. It is proposed to attach an agricultural instructor to each of the botanic stations, who will travel about holding meetings and demonstrations, and imparting information on improved methods directly to the planters; and in addition instructors or experts in special lines, will be employed to spend a month or two on each island. The publications of the department will include handbooks on the cultivation of special crops, bulletins and leaflets—the latter especially being in very simple clear language. The *West Indian Bulletin*, mentioned above, will be issued by the department periodically.

THE PROPOSED NATIONAL UNIVERSITY.

The committee appointed by the National Educational Association to consider the advisability of establishing a national university met in Washington on November 3d, and unanimously agreed upon a preliminary report recommending that no new university be established, but indicating the advisability of using the collections and resources of the government for advanced work and the establishment by the government of a school for consuls. The report of the committee is as follows:

(1) It has been, and is, one of the recognized functions of the federal government to encourage and aid, but not to control, the educational instrumentalities of the country.

(2) No one of the bills heretofore brought before Congress to provide for the incorporation of a national university in Washington commends itself to this committee as a practical measure.

(3) The government is not called upon to maintain at the capital a university in the ordinary sense of that term.

(4) That a sub-committee be requested to prepare for consideration by the full committee a detailed plan by which students, who have taken a baccalaureate degree, or who have had an equivalent training, may take full and systematic advantage of the opportunities for advanced instruction and research which are now, or may hereafter be, afforded by the government; such a plan to include the coöperation with the Smithsonian Institution of the universities willing to accept a share of the responsibility incident thereto. It is understood that the financial administration of this plan should be such that whether or not government aid be given, there shall be no discouragement of private gifts or bequests. It is understood that the scope of this plan should be indicated by the governmental collections and establishments which are now available, or as they may hereafter be increased or developed by the government for its own purposes.

(5) The government, through the State Department, might wisely maintain in Washington a school for consuls, analogous to West Point and Annapolis, and make these schools lead to a life career in the government service.

*RESOLUTIONS OF THE SEVENTH INTERNATIONAL GEOGRAPHICAL CONGRESS.**

(1) The Congress appoints a Committee of Bio-geographers resident in or near Berlin to draw up a uniform scheme of nomenclature for plant formations, and after consultation with non-resident specialists, to revise the same and present it to the Eighth Congress.

(2) The Congress believes that the plans for international coöperation in Antarctic exploration form an excellent basis for joint research in physical geography, geology, geodesy and biology. With regard to meteorological and magnetic work, however, they appoint an international committee to determine the general scheme and methods to be employed on the expeditions, and to endeavor to organize a system of simultaneous observations in the regions surrounding, but exterior to, the Antarctic.

(3) The Congress expresses the earnest desire that all maps, including those published in countries using English and Russian measures, should, in addition to the graphic scale, bear the proportion of lengths on the map to those in nature in the usual form $1 : x$.

(4) The Congress views it as desirable that the publication of all new geographical material accompanying accounts of travel, should be supported by details regarding the methods of surveying, the instruments employed, and their verification, the calculation of astronomical positions with their probable error, and the method of utilizing these data in preparing the map. Also that all maps published by scientific men, institutions or governments should be accompanied by notes of the principal fixed points.

(5) The Congress expresses the hope that a uniform system of measures will be used in all geographical researches and discussions, and recommends that the metric system of weights and measures be so employed.

(6) The Congress expresses the hope that in scientific publications the centigrade thermometer scale should, as far as possible, be employed; or, at least, the values in centigrade degrees added to those expressed on the scales of Fahrenheit or Réaumur.

(7) With regard to the proposal to introduce

* From *Nature.*

a decimal division of time and angles, the Congress desires to preserve the present division of time and of the circumference into 360°, but allows that the adoption of a different subdivision of the angle might be studied, and considers that in certain cases the decimal subdivision of the degree of arc presents no objection.

(8) The Congress is of opinion that the *Bibliotheca Geographica*, published by the Berlin Geographical Society, may be accepted as an efficient international bibliography of geography.

(9) The Congress considers the construction of statistical population maps to be very desirable, and appoints an international committee to draw up a scheme, at the same time expressing the hope that national committees will be formed in various countries to promote the preparation of such maps.

(10) The Congress considers the collection of data as to the distribution of floating ice to be very important, and appeals to the hydrographic and meteorological institutes of the countries whose ships frequent high latitudes to induce the masters of vessels to keep a regular record of the occurrence of drifting ice. The Congress believes that the Danish Meteorological Institute in Copenhagen is the best adapted as an international centre for collecting the records.

(11) The Congress nominates an international committee to consider the nomenclature of the floor of the ocean, and to produce and publish at latest in time for the next Congress a chart of the ocean with revised nomenclature.

(12) The Congress hopes that the names of oceanic islands, especially in the Pacific, will be revised with a view to ascertaining and preserving the native names. Where no native names exist or can be ascertained, the names given by the discoverers should be used. The arbitrary changing of established names ought to be opposed by every means.

(13) The Congress recognizes the desirability of obtaining data for a more exact estimate than now exists of countries in which there is no means of taking a census, and desires to bring the matter to the notice of such Governments as have foreign possessions.

(14) The Congress expresses sympathy with the proposal to equip an expedition in New South Wales, with the sole object of endeavoring to discover remains or traces of the route of the Leichhardt expedition, which perished in the interior of Australia fifty-two years ago.

(15) The Congress is favorable to the foundation of an international seismological society, and appoints an international committee for the study of earthquakes.

(16) The Congress believes the production of a map of the world on the scale of 1:1,000,000, the sheets bounded by meridians and parallels, to be both useful and desirable. The Permanent Bureau of the Congress is instructed to deal with the question, and in the first instance to secure the preparation of a projection for the map with degree lines on the determined scale.

(17) The Congress considers the establishment of an International Cartographical Association of service, and appoints a committee to take preliminary steps.

SCIENTIFIC NOTES AND NEWS.

THE family of the late Dr. Daniel Garrison Brinton have requested Mr. Stewart Culin, of the University of Pennsylvania, to prepare a memoir of the distinguished Americanist. Mr. Culin is desirous of obtaining copies of Dr. Brinton's letters and other literary materials, which may be sent him at the University of Pennsylvania.

PROFESSOR SIMON NEWCOMB has returned to Washington from Europe. His last official services while abroad were to represent, together with Professors Remsen and Bowditch, the National Academy of Sciences at a conference held at Wiesbaden, on October 10th and 11th, to form an International Association of Academies.

SIR WILLIAM MACCORMAC, president of the Royal College of Surgeons, and one of the greatest authorities on gunshot wounds, has volunteered his services in South Africa, and the British War Office has accepted his offer.

MR. ALEX EVERETT FRYE, the geographer, has been appointed superintendent of schools for Cuba.

THE daily newspapers report that Professors Lengfeld and Smith and four students have

been injured by the explosion of chemicals in the Kent Laboratory of the University of Chicago.

DR. MARCUS BAKER, who was one of the experts assisting the United States members of the Venezuela arbitration commission at Paris, has returned to Washington.

DR. LUTHER DANA WOODBRIDGE, since 1884 professor of anatomy and physiology in Williams College, died suddenly of heart disease at his home in Williamstown on November 3d. He was born in 1850 and was a graduate of Williams College and of the College of Physicians and Surgeons, Columbia University.

THE death is announced of the African explorer, Dr. Oscar Baumann, born in Vienna in 1864. In 1885 he acted as geographer to the Austrian Congo Expedition, subsequently visiting the island of Fernando Po, the Cameroons and part of East Africa. He made several further trips to Africa on one of which he explored Usambara and made studies for the projected railway from Tanga to Karog.

DR. J. W. HICKS, fellow of Sidney-Sussex College, Cambridge, and Bishop of Bloemfontein, Orange Free State, has died at the age of fifty-nine. He was at one time demonstrator in chemistry in the University, and was the author of a text-book of inorganic chemistry; he was also doctor of medicine.

WE also regret to record the deaths of Dr. F. Kuhla in Manaos, Brazil, where he was engaged in botanical explorations; of Percy S. Pilcher on October 2d, as the result of an accident while experimenting with flying machines on September 30th, and of Professor Hayduck, privat docent for chemistry at Berlin.

THE National Museum has recently come into possession of a large portion of a stony meteorite which fell at Allegan, Michigan, on July 12th last. A preliminary examination shows the stone to be of the chondritic type, composed essentially of olivine and enstatite with the usual sprinkling of particles of metallic iron and undetermined sulphides. The stone will be known as the Allegan meteorite, and as soon as described will be in part broken up and made available for exchanges with other institutions. The Museum has also received, through Mr. O. C. Charlton, of Waco, Texas, permission to study and describe an iron meteorite found near Mart, McLennan County, in the same state. This mass weighed, entire, 19¾ pounds and will be known as the Mart iron.

THE report of the Australian Museum for 1898 again notes that the appropriation for its maintenance is entirely inadequate and that the Museum is forced to depend entirely on its friends for any increase of the collections. Fortunately the friends are numerous as is shown by the many accessions. There is, however, a special appropriation for the construction of the superstructure of the new wing, the basement, which is devoted to workrooms, having already been built. It is noted that a new and satisfactory crematory has been erected so that as regards facilities for the work of preparation, the Australian Museum is probably far in advance of any institution in the United States, save possibly the Wistar Institute. Part 6 of the Memoir on Funafuti has been published, and two parts of a revised catalogue of Australian birds, and it is announced that the report on Funafuti will be finished this year and that on the Thetis trawling expedition commenced. The Australian Museum is to be congratulated on the amount of work it is able to do with its small appropriation.

Nature reports that at a meeting of the Council of the London Mathematical Society, it was resolved that the president (Lord Kelvin,) the three vice-presidents, the treasurer, and the two secretaries should be nominated for the same offices at the annual meeting on November 9th next. Of the other members, Messrs. W. H. H. Hudson, D. B. Mair and W. D. Niven, C.B., retire from office, and Messrs. W. Burnside, H. M. Macdonald and E. T. Whittaker were nominated to fill the vacancies. The Council also empowered the secretaries to publish an 'Index' to the first thirty volumes of the *Proceedings*, on the lines of the similar index to the first fifty volumes of the *Mathematische Annalen*. Mr. Tucker was further authorized to draw up a complete list of members from the foundation of the society in 1865.

AT the first general meeting this season of

the members of the Boston Society of Natural History, held on November 1st, a paper was read by Professor W. M. Davis on 'Geographical Notes of a Year in Europe.'

PROFESSOR LEITH, on taking the new chair of pathology and bacteriology at Mason University College, Birmingham, on October 9th, delivered an address on the advance of bacteriological science in the diagnosis and prevention of disease.

THE library of Harvard University has sent out circulars to various cattle-breeders' associations throughout the country, requesting them to contribute complete files of their published pedigrees of cattle, horses, sheep and swine. The collection is to aid students in research into the heredity of domesticated animals, and will be placed in the Museum of Comparative Zoology.

A SOMEWHAT acrimonious attack has been made by 'a correspondent' in the Aberdeen *Free Press* upon the trawling work of the Scottish Fisheries Commission. The article has been reprinted and is said to have been widely distributed. The author concludes "that their so-called scientific experiments on trawling have been carried on with no regard whatever to uniformity and in such a slip-shod manner that the public money might, considering the results accruing, have been more profitably thrown into the sea." The author does not explain how the greater profit from the sea is to be secured. He demands an investigation of the work.

ACCORDING to *Nature*, a scientific and commercial mission, under the directon of M. Ernest Milliau, Director of the Laboratory of Technical Experiments in connection with the Ministry of Agriculture, Paris, has been sent to Russia and Roumania with the object of taking measures for facilitating and extending business relations with those countries, especially with regard to the exportation of olive oils.

THE New York *Evening Post* states that Dr. Robert T. Hill of the United States Geological Survey and four companions have arrived at Langtry, Texas, from a voyage through the cañons of the Rio Grande, their trip being the second successful one down that river ever attempted. The party left Presidio, Texas, and completed the five hundred miles of the tortuous course of the river without seeing a human habitation. Veins of gold and silver-bearing rock were seen at several points, and there were indications in the almost inaccessible cañons that they had at one time been occupied by cliff dwellers, but it was found impossible to explore the ruins from below.

MR. JOSEPH B. BANCROFT, of Hopedale, Mass., has built a public library building for that town, at a cost of $50,000, which will be dedicated during the present month.

THE School Board of the City of Chicago has decided to appoint fifty medical inspectors with special reference to preventing the spread of contagious diseases among children. The inspectors will examine pupils who have been absent from school four days or more and all those who show symptoms of fever or sore throat. The plan, which is modeled on that already adopted in New York and Boston, will be tried for two months as an experiment.

THE Committee of the British Association Table at the Naples Zoological Station announces, says *Nature*, that the Table is fully occupied until the middle of April next, but that applications for its occupancy from then until the end of August, 1900, should be sent at once to the Hon. Secretary of the Committee, Professor Howes, F.R.S., at the Royal College of Science, South Kensington. Mr. Kyle will occupy the table from now until Christmas, when he will be succeeded by Mr. M. D. Hill, who will continue investigations on the reproduction processes of Crustacea, and in March Professor Herdman will go out and devote a month to the study of the Tunicata of the Bay.

UNIVERSITY AND EDUCATIONAL NEWS.

MAJOR HENRY LEE HIGGINSON, of Boston, has given $150,000 to Harvard University for the establishment of a university club, and the corporation offers as a site the property at the corner of Harvard and Quincy streets.

IN the Supreme Court of the United States, on October 30th, the petition for a writ of *cer-*

tiorari in the Fayerweather will case was denied. It is reported, however, that the contest involving, it will be remembered, some four million dollars for American colleges is not yet settled.

Liverpool University College has received for its physical laboratories two checks of $5,000 each from Mrs. George Holt and her daughter, Miss Emma Holt.

Arrangements are being made under the direction of Mr. H. J. Rogers, of Albany, for the United States educational exhibit at the Paris Exposition of 1900. It is planned to represent the university system of the United States by letting the different universities each represent some special departments, so that the collective exhibit may not be of separate universities, but of higher education as a whole. In scientific work Johns Hopkins University will exhibit its departments of physics, geology, and the medical sciences, the University of Pennsylvania its archæological collections, Columbia University its library and its work in education and psychology, and Harvard University its astronomical observatory.

The Technical Institute at West Ham, London, was destroyed by fire on December 23, 1898. The fire originated in the chemical laboratory. The loss is estimated at over £80,000 and is only partially covered by insurance. The adjacent Natural History Museum, the gift of Mr. Passmore Edwards, which is now approaching completion, was fortunately saved as were also the books from the free library.

The number of new matriculations at Cambridge University was this year 893 as compared with 902 in 1898 and 884 in 1897.

Dr. Alonzo E. Taylor, Assistant Director of the Pepper Laboratory of the University of Pennsylvania, has been appointed professor of pathology in the Medical College of the University of California.

Dr. Alex. Hill, Master of Downing College, in his speech to Congregation on resigning the office of Vice-Chancellor of the University of Cambridge, stated, says the British *Medical Journal*, that the amount already received towards the Benefaction Fund instituted at the meeting over which the Duke of Devonshire presided at Devonshire House, amounted at the end of the financial year, to £50,000. It had thus been made possible to consider the erection of new buildings for law, medicine, botany and archæology. The response, however, had not been sufficient to warrant any of the new developments of University work which many friends of the University desired. In the interests of national progress, Dr. Hill said, it was greatly to be desired that laboratories of applied science should not be isolated but should be established in connection with schools which were already strong in pure science. Technical training in any limited sense of the expression was impossible. In every subject of practical application—whether it were to a learned profession or an industrial art—success depended upon breadth of knowledge of the sciences upon which the profession or art was based. Advances in technology were almost invariably due to the application by practical men of principles discovered by those who carried out investigations in pure science. Conversely, the strength and vitality of a school of pure science was largely increased when opportunities were afforded to students of passing on to its applications. The remarkable progress of natural science in Cambridge was closely associated with the growth of the medical school. During the past twelve years a larger number of students had entered for the Natural Science Tripos than for any other examination for honors, notwithstanding the fact that but few students were in a position to allow their prospects in life to depend upon the discovery in themselves of a special aptitude for pure science. Almost all those who had since distinguished themselves in various branches of science had commenced their career by preparing to qualify for a profession. The majority of the graduates, for example, who were at present prosecuting researches in the physical, chemical, botanical, zoological, physiological, anatomical and pathological laboratories, making, to the great credit of the University, additions to knowledge which were not exceeded, if they are equalled in amount, by any other university in the world, entered as medical students.

JOHN WELLS FOSTER.

SCIENCE

FRIDAY, NOVEMBER 17, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.**

III.

GOULD.

Gould † was born in Boston in 1824, and was graduated with honors at Harvard twenty years later. He then went abroad and for four years studied under the most distinguished astronomers of Europe, but chiefly under the great Gauss, in Göttingen, where he received his doctor's degree.

In 1848 he returned to Boston, and there —a little more than half a century ago— began the publication of the *Astronomical Journal*, the first and still the only distinct periodical of that science devoted to original investigation in this country.

Then came his valuable connection with the Coast Survey, during which he had charge of the longitude determinations, and subsequent to the laying of the Atlantic cable in 1866, he connected the two continents by precise observations. These first determinations of transatlantic longitude by telegraph were the means of establishing a connected series of longitude measurements from the Ural Mountains to New

* Address of the Vice-President and Chairman of Section I of The American Association for the Advancement of Science, Columbus Meeting, August, 1899.

† See sketch with engraved portrait on wood in *Popular Science Monthly*, Vol. XX., p. 683. March, 1882.

Orleans. In the successful accomplishment of this work he anticipated his English colleagues, and so added greater renown to the advancement of American science.

From 1856 to 1859 he was director of the Dudley Observatory in Albany, and superintended its construction. It was in this building that the normal clock, protected from atmospheric variations and furnished with barometric compensation, was first used to give time telegraphically to dials throughout the observatory; indeed, as improvements of his own suggestion were established, the service was extended until it was that clock that gave the time signals to New York. The three years of his valuable services to science at Dudley were marred by a famous controversy, the discussion of which cannot be taken up here. It had to do with the important question as to whether the wishes of a board of trustees should be carried out by a scientific director. Gould absolutely declined to accept the dictates of those who determined to compel him to adopt a policy which was opposed to that which he regarded as best for the scientific development of the observatory. Firm in his belief as to what was right, he declined to resign, and finally, by process of law, was removed from his directorship. Gould fought his fight bravely and honestly, and though in the end he was unsuccessful, still to his credit it must be said, he never yielded his ground.

The great event of his life was the magnificent work accomplished by him while director of the National Observatory of the Argentine Republic in Cordoba. In 1868 he was called to the organization of the observatory there, and after obtaining from Europe a complete outfit of instruments, superintended the erection of the observatory.

He began work in 1870. Of the work accomplished he said:

> The original purpose was to make a thorough survey of the southern heavens by means of observations in zones between the parallel of 30° and the polar circle; but the plan grew under the influence of circumstances, until the scrutiny comprised the whole region from the tropic to within 10° of the pole—somewhat more than 57° in width, instead of 37°. Although it was no part of the original design to perform all the numerical computations, and still less to bring the results into the form of a finished catalogue, it has been my exceptional privilege, unique in astronomical history so far as I am aware, to enjoy the means and opportunity for personally supervising all that vast labor, and to see the results published in their definite, permanent form.*

It was also under his direction that the Argentine Meteorological Service was established in 1872, and its work he described as follows:

> At the end of the year 1884 there were already twenty-three points at which the observations had been continuously made, three times a day, for at least four years, and sixteen others at which they had already been continued for more than two years. These have provided the necessary data for constructing the isothermal lines, with tolerable precision, for all of South America from the Torrid Zone to Cape Horn.†

His work done, and well done, he came home to pass the evening of his life with the friends and associates of his early years. His return to the United States was celebrated by a dinner, at which those who knew him best, greeted him with glad words of welcome. Holmes wrote for that occasion:

> Once more Orion and the sister Seven
> Look on thee from the skies that hailed thy birth—
> How shall we welcome thee, whose home was Heaven,
> From thy celestial wanderings back to earth?

* Addresses at the Complimentary Dinner to Dr. Benjamin Apthorp Gould, p. 15.

† Idem, p. 17.

Fresh from the spangled vault's o'erarching splendor,
Thy lonely pillar, thy revolving dome,
In heartfelt accents, proud, rejoicing, tender,
We bid thee welcome to thine earthly home.*

Advancing years came pleasantly to him. In Cambridge he reëstablished the *Astronomical Journal*, the special pride of his early life, and honors, such as are accorded only to the very great, came to gladden him with their special significance of recognition and appreciation. A dozen peaceful years were spent in the quiet of his own home before the end came, and then he passed beyond the stars to his new home in the far-away skies.

The meeting in Chicago brought into conspicuous notice one of the pioneers in American geology, whose fine attainments had been honored locally by his election to the presidency of the Chicago Academy of Sciences. Our Association was quick to recognize the growing advancement of science in the west by electing John Wells Foster to preside over the Salem meeting in 1869.

FOSTER.†

Foster was born in Petersham, Massachusetts, in 1815, and was a lineal descendant of Myles Standish, of Mayflower celebrity. He was educated at Wesleyan University, and then studied law. In the early thirties Ohio was still the El Dorado of New England, and Foster settled in Zanesville, where he completed his law studies and was admitted to the bar.

In 1847 the national government instituted a geological survey of the Lake Superior region, which at that time was attracting much attention, owing to the discovery of the copper deposits there. Charles T. Jackson was appointed in charge of the expedition, and he chose as his assistants Foster and Josiah D. Whitney. On the completion of the work, two years later, the preparation of the report was assigned to the younger men. The two slender volumes were published by Congress, and still remain the accepted authority on the subject of which they treat. It was at the Cincinnati meeting of our Association in 1851, that the elder Agassiz 'declared it to be one of the grandest generalizations ever made in American geology.'

He returned to Massachusetts and was active in politics, serving for some years as one of the Governor's executive council, but in 1848 he again went west, and Chicago became his permanent home. For some years he had charge of the land department of the Illinois Central Railroad and then held a similar connection with the Chicago and the Illinois Central Railroad, and then held a similar connection with the Chicago & Alton Railroad, but he relinquished these appointments to return to the pursuit of science, and accepted a chair of natural history in Chicago.

He was the author of 'The Mississippi Valley, Its Physical Geography,' which gave valuable sketches of the topography, botany, climate and geology of that part of the United States. His last work, published shortly before his death, was on Prehistoric Races of the United States, and gave the results of his investigations of the mounds found in various places in the Western States. He was the editor of the *Lakeside Monthly*, and a frequent contributor to literary and scientific periodicals. It was said of him that "his varied experience, his wide and accurate knowledge of facts, his intellectual comprehensiveness, and discriminativeness made him the peer of the foremost scholars of his time, while his personal and social qualities made him respected and loved by all who came within the radius of his winning personality." He died in 1873.

* Addresses at the Complimentary Dinner to Dr. Benjamin Apthorp Gould, p. 22.

† A portrait of John Wells Foster is published as Frontispiece.

CHAUVENET.

The gathering in the west was succeeded by one in the east, and Troy, N. Y., was selected as the meeting place of our Association in 1870. William Chauvenet was chosen to preside, but as the time came for the gathering of the scientists his health was so precarious, and his end so near, that he was unable to be present, and the vice-president, Thomas Sterry Hunt, occupied the chair. Both names are included in the list of our presidents, and a brief sketch of each is therefore given.

Chauvenet* was born in Milford, Pennsylvania, in 1824, and was graduated at Yale in 1840. The mathematical ability that he had shown while in college led to his prompt appointment as assistant to Alexander D. Bache, who gave him charge of the reduction of the meteorological observations then being carried on at Girard College. A year later, however, in 1841, he received an appointment as professor of mathematics in the United States Navy, and continued in that capacity until 1859. At first he served on board of the steamer *Mississippi*, and later at the Naval Asylum in Philadelphia, but he became greatly interested in the proposed establishment of the United States Naval Academy, in Annapolis, and when that institution became a reality he was transferred there, receiving the chair of astronomy, navigation, and surveying, and was 'always the most prominent of the academic staff.'†

In 1855 the chair of mathematics, and in 1859 the chair of astronomy and natural philosophy, at his *alma mater*, were offered to him, but the rigors of the northern winters he feared would be too severe for his delicate constitution, and he declined to accept either of them. But in the last-named year he was called to the professorship of mathematics in the then recently founded Washington University in St. Louis, and in 1862 he was made chancellor of that university, but two years later failing health compelled him to abandon all active work, and he sought recuperation in travel. In 1865, with apparently restored health, he was able to practically resume his duties, but four years later he was obliged to relinquish them entirely. It was at that time that he was elected to the presidency of our Association, but he was unable to attend the meeting, and in December, 1870, he died in St. Paul, Minnesota. Mention should be made of the fact that he served the Association as general secretary at the Springfield meeting in 1859.

There have been men of extraordinary ability, there have been men of great talents, and there have been famous students who have laboriously worked out important discoveries, among those who have held the high office of president of our Association, but among them all, two only, Hunt and Cope, it seems to me, possessed those brilliant mental qualities which are the natural endowments of genius.

HUNT.

Hunt* was born in Norwich, Connecticut, in 1826, and was descended from William Hunt, one of the founders of Concord, Massachusetts, in 1635. His maternal grandfather was Consider Sterry, of Norwich, a well-known mathematician and civil engineer in his time. His early education was slight, but as a young man he became laboratory assistant in the chemical

* Biographical Memoirs of the National Academy of Sciences, Washington, 1886, Vol. I., p. 227, William Chauvenet, by J. H. C. Coffin.

† Biographical Memoirs, p. 235.

* See *Popular Science Monthly*, Vol. VIII., p. 486, February, 1876, with an engraved portrait on wood. See also sketch with half-tone portrait in *Engineering and Mining Journal*, November 7, 1891, and sketch by R. W. Raymond in that journal for February 20, 1892. The *Scientific American* of March 19, 1892, likewise contains a sketch of Hunt with a half-tone portrait.

department of Yale under the elder Silliman. Seldom has an opportunity been used to greater advantage, and so quickly did he acquire a knowledge of the sciences presented, that after two years in New Haven he was, in 1847, appointed chemist and mineralogist to the Geological Survey of Canada, a place which he then held for exactly a quarter of a century. During that period, with his unusual powers, he presented to the scientific world those remarkable contributions to the twin studies of chemistry and geology that have gained for him a foremost place among the pioneers of the newer science of geological chemistry. His early papers treated of chemistry. He developed a system of organic chemistry in which all chemical compounds were shown to be formed on simple types represented by one or more molecules of water or hydrogen.* He anticipated Dumas with his researches on the equivalent volumes of liquids, and in 1887 published in book form, under the title A New Basis for Chemistry, a full digest of his papers, forming a complete system of his theory of chemistry.

In 1872 he returned to the United States and accepted the chair of geology in the Massachusetts Institute of Technology made vacant by the retirement of William B. Rogers, and remained in that capacity until 1878, after which New York City became his principal home, and he devoted his leisure, until his death, in perfecting his books, which present in matured form the opinions originally published as addresses or special papers. They include Chemical and Geological Essays; Mineral Physiology and Physiography; and Systematic Mineralogy According to a Natural System, and according to R. W. Raymond, 'constitute a monument to his genius, industry, and learning which certainly cannot be overlooked by the historian of science.''*

* See a Century's Progress in Chemical Theory. *American Chemist*, Vol. V., p. 56, August, 1874.

Three times during the life of our Association has the science of botany been conspicuously honored by the selection of its most distinguished representative to preside over one of our meetings. The first of these occasions was in 1855 when the able Torrey filled the presidential chair with much grace and dignity, and the second was at the Indianapolis meeting in 1871, when Asa Gray was the presiding officer.

GRAY.

Gray† was born in the Sauquoit Valley, in New York, in 1810, and was the son of a farmer. At an early age he showed a greater fondness for reading than for duties around the farm, and his father wisely decided to make a scholar of him. He was sent to school in Clinton, New York, and later to an academy in Fairfield, New York. At the last-named place in compliance with the desires of his father he entered the medical school, and in 1831 received his doctor's degree from that institution. Meanwhile, however, he acquired an interest in natural science, largely through the influence of Dr. James Hadley, the professor of materia medica and chemistry. Farlow says 'he was not at first so much interested in plants as in minerals,'‡ and this is of special interest, for it was about that time that he first met Dana, with whom he ever afterward maintained a close friendship.

* *Engineering and Mining Journal*, February 20, 1892.

† See Memorial of Asa Gray reprinted from the Proceedings of the American Academy of Arts and Sciences, and Biographical Memoirs of the National Academy of Sciences, Vol. III., p. 161, Asa Gray, by W. G. Farlow. See also Letters of Asa Gray, by Mrs. Jane Loring Gray, 2 vols. Boston, 1893; and Scientific papers of Asa Gray, selected by Charles S. Sargent. 2 vols. Boston, 1888.

‡ Memorial of Asa Gray, p. 20.

It is also Farlow who is my authority for the statement 'that his passion for plants was aroused by reading the article on Botany in the Edinburgh Cyclopædia,'* and with a fondness for collecting, we learn that even before graduating 'he had brought together a considerable herbarium.'†

It does not appear that he ever practiced medicine, for during the same year that he graduated he became instructor in chemistry, mineralogy, and botany, in the high school in Utica, and he also lectured on these subjects at the medical school.

In 1833 he went to New York, where he joined Torrey, whose assistant he became, and two years later, through Torrey's influence, he was appointed curator and librarian of the Lyceum of Natural History, now the New York Academy of Sciences. About that time the preliminary arrangements for the Wilkes Exploring Expedition were being made, and the place of botanist was accepted by Gray. It was the fact that his friend Gray had accepted an appointment on the expedition that led Dana to consider favorably an invitation to serve as its mineralogist. However, the departure of the expedition was delayed for some time, and in the meanwhile Gray resigned to accept a closer relationship with Torrey, who sought his association in the preparation of his Flora of North America.

The organization of a great university is in many ways a formidable undertaking, and the selection of its faculty is, perhaps, the most difficult of all the problems that come up for consideration. Some sixty years ago the University of Michigan elected Asa Gray as its first professor of botany. He accepted the honor, but asked that he be permitted first to spend a year abroad in study. The splendid opportunities for settling disputed points in American botany, as well as the association with many students of science who have since become eminent, was fruitful of rich results, and so it was that on his return the continuation of the Flora demanded his first attention. The young university in the west lost his services, but botany as a science, was the gainer. Later, perhaps, he might have settled in Ann Arbor, but in 1842 an opportunity, such as comes to but few men, came to him when he was invited to accept the Fisher professorship of Natural History in Harvard. At that time 'there was no herbarium, no library, only one insignificant greenhouse, and garden, all in confusion with few plants of value.'* To describe the development of the botanical department of Harvard, as guided by him, would take more space than I can rightly give, and in this case it is not necessary to attempt it, for in the Memorial of Asa Gray, from which much has already been taken, the story is told by his three friends and associates, Goodale, Watson and Farlow, each of whom succeeded to a share of his work. I may, however, say that at the time of his death, in 1888, the herbarium, the largest and most valuable in America, contained over 400,000 specimens, the library had more than 8,000 titles, the 'insignificant greenhouse' had been increased many fold, and the garden had become the most important of its kind in this country.

Like Louis Agassiz, Wolcott Gibbs, Jeffries Wyman, and other of his great contemporaries at Harvard, his influence as a teacher was remarkable, and it was well said of him that 'he trained up a whole race of botanists, now scattered through all parts of the United States.'† Like Dana, his influence was extended by his text-books throughout the English-speaking world. His Elements of Botany, first published in 1836, became later the Structural and Systematic

* Memorial of Asa Gray, p. 20.

† Idem, p. 20.

* Memorial of Asa Gray, p. 26.

† Idem, p. 28.

Botany. The well-known Manual of the Botany of the Northern United States is still a classic. How Plants Grow and How Plants Behave "found their way where botany as botany could not have gained an entrance, and they set in motion a current which moved in the direction of a higher science with a force which can hardly be estimated."*

In conclusion let me quote the words of Dr. J. E. Sandys, of Cambridge, who, in conferring the Degree of Doctor of Science from that famous old University, said:

> This man who has so long adorned his fair science by his labors and his life, even unto a hoary age, 'bearing,' as the poet says, 'the white blossoms of a blameless life,' him, I say, we gladly crown, at least with these flowerets of praise, with this corolla of honor. For many, many years may Asa Gray, the venerable priest of Flora, render more illustrious this academic crown!†

SMITH.

The brilliant work in chemistry done by J. Lawrence Smith, combined with the fact that prior to his election no representative of chemistry had ever been chosen as president of our Association, had doubtless much to do with his selection to preside over the gathering held in Dubuque, Iowa, in 1872. The wisdom of the choice was confirmed early in that year by his election to the National Academy of Sciences.

Smith‡ was born in Charleston, South Carolina, in 1818, and studied civil engineering at the University of Virginia, but preferring medicine, he was graduated in 1840, at the Medical College in Charleston, submitting as his thesis a valuable paper on 'The Compound Nature of Nitrogen.' As was largely the custom in those days, he spent several years in Europe, passing his winters in Paris, where he studied chemistry with Dumas, toxicology with Orfila, and physics with Becquerel, and his summers in Giessen studying with the immortal Liebig. While he was in Paris the celebrated poison case of Madame La Farge occurred, in which the question of the normal existence of arsenic in the human system was involved, and although he was a student under Orfila, he did not hesitate to differ with his master and review the entire question in a paper, in the conclusion of which in after years, Orfila himself agreed. It was in that way that his interest in medicine became subordinate to that of chemistry.

In 1844 he returned to Charleston, where he entered on the practice of his profession, and during the winter delivered a course of lectures on toxicology in the medical college.

The development of mineral wealth in the different states was beginning to be considered an important matter, and in South Carolina Smith's recognized ability and education led to his appointment as state assayer to test the bullion coming into commerce from the states of Georgia and the two Carolinas. This place he accepted, and so relinquished his practice.

It naturally followed that he should devote some attention to agricultural chemistry, and the great marl beds on which the city of Charleston stands attracted his notice. It was he who "first pointed out the large amount of phosphate of lime in these marls, and was one of the first to ascertain the scientific character of this immense agricultural wealth."* Dr. Smith also made a valuable and thorough investi-

* Memorial of Asa Gray, p. 32.

† Asa Gray, by Walter Deane, with an electrotype portrait, *Bulletin of the Torrey Botanical Club*, Vol. XV., p. 70.

‡ Biographical Memoirs of the National Academy of Sciences, Vol. II., p. 217. John Lawrence Smith, by Benjamin Silliman, with a Bibliography. See also Original Researches in Mineralogy and Chemistry, by J. Lawrence Smith, Louisville, 1884. This memorial volume contains several biographical sketches and a portrait of Dr. Smith.

* Dr. J. B. Marvin in Original Researches, etc., p. 10.

gation into the meteorological conditions, character of soils, and culture affecting the growth of cotton.

This work attracted considerable attention, and in consequence he was regarded by James Buchanan, then Secretary of State, "as a suitable person to meet the call from the Sultan of Turkey for scientific aid in introducing into that kingdom American methods in the culture of cotton."* On reaching Turkey he found that a commission was already engaged on the problem of cotton culture, and as he was about to return, the Turkish government invited him to report on the mineral resources of its territory. This work proved most valuable, and his discoveries of emery deposits in Asia Minor destroyed the monopoly then held by the Island of Naxos.

In 1850 he returned to the United States, and for two years lectured on science in New Orleans, and was elected professor of chemistry in the University of Louisiana, an institution which he said "at present exists but in name." Two years later he was called to succeed Robert E. Rogers in the chair of chemistry in the University of Virginia, and then began with George J. Brush that splendid series of analyses of American minerals. Silliman said of them: "They settled many doubtful points and relegated into obscurity many worthless theories, while clearly establishing others."†

His stay at the University of Virginia was a short one, for at the end of the year he resigned and settled in Washington, where he became connected with the Smithsonian Institution as chemist, also devoting some attention to agricultural chemistry for the Department of Agriculture.

Louisville was the home of his wife's family, and the chair of medical chemistry and toxicology in the University of Louisville, made vacant by the resignation of the younger Silliman, was tendered to him in 1854. That place was promptly accepted, and therefore Louisville became his home. For twelve years he continued his professorial duties, and also manifested his fondness for practical chemistry by his acceptance of the charge of the Louisville Gas Works, and by his establishing with the venerable Dr. Edward R. Squibb a laboratory for the production of chemical reagents and the rarer pharmaceutical preparations.

It was during the year that he was connected with the Smithsonian Institution that our Association met in Washington, and for that meeting he prepared his first memoir on meteorites, a subject to which he had become attracted by his purchasing the collection belonging to Gerald Troost, of Nashville. The study of these interesting bodies became thereafter his favorite subject of investigation, and about forty of his papers were devoted to them. He was active in collecting specimens of American falls, and his collection which contained representatives of 250 falls, passed on his death to Harvard University, swelling that collection until it became the best in the country.

His study of meteorites led naturally to his devising improved methods of analysis, especially of the silicates, and while in Paris on one of his many visits there he became interested in the discovery of new elements in the complex mineral samarskite. He devoted much attention to the isolation of its constituents, and at the St. Louis meeting of our association announced the discovery of what he believed to be a new element, to which he gave the name of Mosandrum. The announcement of the isolation of a new element by a past president, gave to the chemical section in 1878, an impetus and dignity that it has never relinquished. Dr. Smith was also present at the Boston meeting, and it was about that time that he further announced his discovery of certain

*Silliman in Original Researches, etc., p. 27.

†Idem, p. 3?.

rare earths, for one of which, should it prove to be an element, he proposed the name of Rogerum, in honor of our William B. Rogers.

Our Association has always been fortunate in its permanent secretaries. They have all been devoted to the interests of the organization and two of them held office for many years. The first permanent secretary was Spencer F. Baird, who was chosen to that office at the Cincinnati meeting in 1851, and continued as such until 1854, when he was succeeded by Joseph Lovering, who then filled the place until 1873, when he in turn was succeeded by the present retiring president, Professor Putnam. Lovering's valuable services were recognized by his election to the presidency in 1872, and he presided over the meeting held in Portland a year later.

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM.

(*To be concluded.*)

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*THE CLASSIFICATION OF BOTANICAL PUBLICATIONS.**

A RECENT number of SCIENCE,† in continuation of the discussion of the proposed international catalogue of scientific literature, to which space has been devoted in that journal for some months past, deals with the question of botany, and the article referred to must be considered as my excuse for the presentation to the Society of the following observations, which are intended solely as suggestions which, in part, may be helpful in starting the botanical portion of the proposed catalogue on lines which are likely to make it of the simplicity, coherence and general usefulness which all desire it to possess.

In the article referred to, Professor Bessey has called attention to a paper prepared by the writer, some years since, for the Botanical Seminar of the University of Nebraska, which was intended to present before that body the results reached in the handling of a rather large library, the purpose of which is entirely botanical, applied botany and the arts based thereon of necessity being included. The subject now under consideration, while fundamentally the same as that handled in the unpublished paper referred to, is, however, practically quite different in the details of its management. In the paper referred to, the problem analyzed was that of the arrangement of a library which, devoted to botany, stood in isolation from other libraries, so that many works were of necessity included in it because of their bearing on botanical subjects, although in title and in some instances in substance not at all botanical. The subject requiring consideration in connection with the proposed catalogue, however, is that of a purely botanical library which may be supposed to stand in the closest possible connection with collections of works referring to all other branches of knowledge—or, stated otherwise, the botanical part of a general library—and is, therefore, in many respects a simpler one. The first mentioned can scarcely be so handled as to meet with the approval of general librarians or of librarians whose subjects are restricted but not botanical, because general knowledge and other sciences are of necessity warped therein that they may be bent to the requirements of the single specialty to which each book which finds a place on the shelves is subordinated. The second, on the other hand, calls primarily for a simple but logical classification of botanical knowledge, with provision for the insertion in it of a relatively small number of non-botanical works which are in such frequent demand as to call for the provision of a special copy

* Read before the Columbus meeting of the Botanical Society of America, and by request of the Society before Section G of the American Association for the Advancement of Science at the Columbus meeting.

† N. S. **10**: 46–8. Jl. 13, 1899.

for the botanical library, in addition to that which would be found on other shelves.

It would at first sight seem quite unnecessary that the classification of botanical knowledge, or, for that matter, of knowledge in any department, for special library purposes, should demand consideration in connection with the preparation of any catalogue or the arrangement of the books on the shelves of any library, since the entire subject and its various parts have frequently been handled by people of large experience; but, as Professor Bessey has shown, the treatment of any specialty, and particularly of one in which development has been rapid and interest limited to a relatively small number of people, by a general librarian, to whom it is of minor importance since it represents only one small fraction of his field, is likely to be unsatisfactory to the student who wishes to enter into its minutiæ, while, on the other hand, the classification of such special knowledge by a specialist is likely to be carried into such detail as to make it too complicated for general purposes.

The scheme which is submitted below is essentially the same as the purely botanical portion of the unpublished scheme referred to by Professor Bessey, with the modification of certain details which are not necessary for ordinary library purposes. While the attempt to adhere to any numerical or similar division of a subject is certain to be attended by so many inconsistencies as to make it undesirable to be biased by it, the convenience of a decimal arrangement is so great that in this scheme several subjects, which are really primary, have been divided so as to make nine principal topics, the subdivision of which, then, has been arranged into such a number of parts in each case as seemed desirable. It is to be understood that in the list subjects which are either mixed or of too indefinite a character to find place under subdivisions will naturally take place under the general division to which they obviously pertain, and in each section the arrangement would be alphabetical by authors. As herein proposed, the scheme of topics would be stated as follows:

BOTANY.*

1. Works of miscellaneous contents, but of botanical interest, and treatises on several branches of botany.
2. Biographies of botanists, and collected writings of miscellaneous contents, whether purely botanical or botanical in part only.
3. Nomenclature, taxonomy and descriptive botany.
4. Morphology and organography.
5. Vegetable physiology, including ecology.
6. Vegetable pathology, including the injuries of plants and therapy.
7. Evolution, natural selection, etc.
8. Man's influence on plants, artificial selection, etc.
9. Phytogeography, floras, etc.

These general topics, for the purposes of any but the most special branch of botany, seem capable of logical subdivision in the way that is indicated below, without introducing a complexity beyond the endurance of anyone competent to handle a general library in which modern science is fairly represented, but any topic represented by only a few works can readily be left undivided until division becomes necessary. Where the number of works becomes too great for convenient handling in any ultimate division as here stated, the specialist, who alone will have occasion to handle a collection of the kind, can readily subdivide to any extent that he may wish; but it should be remarked that beyond the actual needs of subdividing any topic, such

*To bring this scheme into agreement with a resolution of Section G, recommending "as a basis for the classification of a botanical library, the decimal system now in common use in the United States," it is necessary only to designate 'Botany' as 580, and to prefix 58 to each numeral as here used: *e. g.*, 5.111 becomes 585.111, etc.

subdivision had best not be resorted to, since the larger the number of divisions the greater the probability of getting works, by accident, in the wrong class, and the greater the difficulty which the person not a specialist will experience in knowing where to look for any given work, unless the most rigid care is taken in shelf-marking the catalogue cards to the last degree.

BOTANY.

1. Works of miscellaneous contents, but of botanical interest, and treatises on several branches of botany.
    1.1 General treatises containing more or less matter of botanical interest, when these find place on the botanical shelves.
        1.11 Publications of societies, colleges, museums, etc.
            1.111 Botanical gardens, parks, etc.
        1.12 Journals, excepting those restricted to some single branch of botany.

These three classified geographically. In the library referred to, the geographical sequence used is that of Dewey's classification, and the numerals adopted to indicate it are the essentials of his geographical numerals as arranged, for example, under his 938–939, beginning with 38–9 Circum-Mediterranean region, including more than one continent, 40 Europe, to 99 Antarctic region, the minuteness of the subdivision of any given geographical area being made to conform to the number of works on that area possessed by a given library. It is evident, however, that the sequence adopted by Dewey is by no means a satisfactory biological sequence, and, were his system not in very considerable use, it would be far better to arrange a more logical sequence.

1.13 Text-books, lecture-outlines, etc.

Those restricted to special subjects would be sought under such subjects.

1.2 Dictionaries and encyclopædias.
1.21 Language dictionaries.
1.22 Encyclopædias, technical dictionaries.
1.23 Nomenclators, dictionaries of plant names, and purely botanical encyclopædias.

Botanical encyclopædias which are in the nature of synopses of the vegetable kingdom or certain of its parts would be sought in the special group, treated under Taxonomy.

1.24 Bibliographic aids of general contents.
1.25 Indexes to illustrations and exsiccatæ.
1.3 Icones.

A convenient class for botanical gardens and the like, but, when used at all, comprising works which would generally be distributed among monographs, floras, journals, etc., with greater propriety.

1.4 Popular and economic botany.
1.41 Botany of literature.
1.42 General and miscellaneous economic botany.
1.421 Botany of agriculture.

Revisions of special groups of economic plants pertaining to this and the following entries might also be sought under Taxonomy.

1.422 Botany of horticulture.
1.4221 Fruits.
1.4222 Vegetables.
1.4223 Decorative plants.
1.423 Botany of forestry.
1.4231 Dendrologies, sylvas, etc.

Local floras would also be consulted.

1.42311 Winter manuals.

Other seasonal manuals, seedling manuals, etc., may be arranged as other subdivisions of 1.4231, if desired.

1.4232 Anatomical classification of woody plants.
1.42321 Strength and properties of timber.
1.424 Botany of pharmacy, food adulteration, etc.
1.4241 Poisons and toxicology.
1.4242 Mechanical effects of vegetable substances.
1.4243 Histological pharmacognosy.

2. Biographies of botanists, and collected writings of miscellaneous contents, whether purely botanical or botanical in part only.
3. Nomenclature, taxonomy and descriptive botany.

Under one or more of the divisions of this group it may be convenient to insert subdivisions for journals, proceedings of societies, etc.

3.1 Spermatophytes (Phanerogams).

The orders in numerical sequence, after Durand or Engler and Prantl.

According to the needs of different libraries a greater or less withdrawal of works from this group, for distribution under Ecology and other heads, is to be expected. Memoirs on fossil plants would find place here. Geological and geographical considerations would go under local floras or Ecology if placed on the botanical shelves.

3.2 Pteridophytes.

Subdivided after Engler and Prantl when desired.

3.3 Bryophytes.

Subdivided after Engler and Prantl in case of need.

3.4 Thallophytes.

Algæ, lichens and fungi are best recognized in a library arrangement, since no other scheme of classifying the thallophytes has yet led to the production of any considerable amount of literature based on such scheme.

3.41 Algæ and Characeæ.

3.42 Fungi.

3.421 Lichens.

3.422 Fungi in the restricted sense.

In some libraries this group will require division numerically, according to Saccardo's Sylloge or Engler and Prantl.

3.423 Yeasts and alcoholic fermentation.

3.424 Bacteria, germ diseases, etc.

3.425 Mycetozoa.

4. Vegetable morphology and organography.

4.1 External morphology, classification and description of plant members.

4.11 Morphology proper.

4.111 Thallus.

4.1111 Root.

4.1112 Shoot.

4.11121 Stem.

4.11221 Leaf.

4.1113 Types of branching.

4.11131 Inflorescence.

4.1114 Flower.

4.11141 Receptacle.

4.11142 Perianth.

4.111421 Calyx.

4.111422 Corolla.

4.11143 Andrœcium.

4.11144 Gynœcium.

4.1115 Fruit.

4.11151 Seed.

4.1116 Appendages.

4.11161 Trichomes, prickles, etc.

4.11162 Sori, sporangia.

4.11163 Archegonia.

4.11164 Antheridia.

4.11165 Embryo sac., etc.

4.11166 Pollen, pollen plants.

For this entire subject Anatomy, Physiology, and the several groups under Taxonomy, would be consulted. Subdivisions may easily be made when required.

4.12 Embryology.

With frequent reference to development, germination, etc.

4.13 Organography.

Subdivided like Morphology.

4.131 Nomenclature of color as applied to plant description.

General treatises on color would, of course, be sought under physics.

4.2 Vegetable anatomy and histology.

4.21 Laboratory manuals, technique, microscopy, photomicrography.

Subdivided if necessary.

4.22 Cytology.

4.221 Cytology.

4.2211 Protoplasm.

4.2212 Plastids.

4.2213 Nucleus.

4.222 Cell contents.

4.223 Cell wall.

4.23 Histology of plant members.

Subdivided at will, like 4.11.

4.231 Histological classification of plants.

See also Botany of forestry, Botany of pharmacy, Taxonomy.

4.3 Teratology.

Deformities and injuries caused by insects, fungi, etc., would be sought under these heads, and under Vegetable pathology.

5. Vegetable physiology.

5.1 Physiology proper.

5.11 Vegetative processes.

5.111 Absorption and conduction of fluid.

Dew plants, rain plants, carnivorous plants, etc., would be sought under Ecology.

5.112 Transpiration.

The phenomena of so-called frost plants, etc., also conveniently classed here ; the protective function of stomata, perhaps, under Ecology.

5.113 Plant food, nutrition.

5.1131 Photosynthesis.

5.1132 Metabolism, respiration, secretion.

5.1133 Nutrition.

5.114 Growth, protoplasmic activity.

5.1141 Turgescence.

5.1142 Growth.

5.11421 Circumnutation.

5.1143 Development.

5.1144 Cell division.

Much cytological matter, of necessity, under histology.

5.1145 Protoplasmic movements, irritability.

5.11451 Heliotropism, geotropism, hydrotropism, etc.

See also growth.

5.1146 Germination.

See also 4.11151, 4.12, and 5.1143.

5.12 Reproductive processes.

5.121 Vegetative propagation.

Subdivided, when desired, either on morphological lines or by plant groups. Morphology, Organography and Ecology would be frequently consulted here.

5.122 Sexual reproduction.

5.1221 Differentiation of sex.

5.1222 Heterospory, alternation of generations.

5.1223 Fecundation.

5.1224 Reproduction of Thallophytes

5.12241 Conjugation.

5.12242 Oophytic fertilization.

5.12243 Carpophytic fertilization.

5.1225 Reproduction of Archegoniatæ.

5.12251 Bryophytes and Pteridophytes.

5.122511 Antherozoids.

5.122512 Egg cells.

5.12252 Gymnosperms.

Subdivided like preceding.

5.1226 Reproduction of Siphonogamæ.

5.12261 Pollen and pollen plants.

5.12262 Ovules.

General morphology, Embryology, and Germination, to be consulted.

5.2 Ecology.

5.21 Vegetative interrelations.

5.211 Phenology.

5.212 Nutritive adaptations.

5.2121 Plankton, aquatics, ice plants, dew plants, etc.

5.2122 Climbing plants.

5.2123 Carnivorous plants.

5.2124 Parasites, symbionts.

5.213 Protective adaptations.

5.2131 Compass plants, epiphytes, halophytes, xerophytes, sleep of plants, etc.

Chloroplast movements and the protective adjustment of stomata would be sought under Physiology proper. This may be subdivided as needed.

5.2132 Spines, secretions, raphides.

See also 4.11, 4.222, and 5.1132.

5.2133 Myrmecophilism, acarophilism.

5.22 Reproductive interrelations.

5.221 Pollination.

5.222 Dissemination.

6. Vegetable pathology including the injuries of plants, and therapy.
7. Evolution, natural selection, etc.
8. Man's influence on plants, artificial selection, etc.

Economic botany would be consulted here.

9. Phytogeography, floras, etc.

9.1 Geographical botany.

Ecological considerations would be sought under Physiology.

9.2 Floras.

Subdivided, according to abundance in each area, geographically like periodicals, etc. Travelers' journals of restricted scope, and similar works directly or indirectly throwing light on a local flora, reports of geological surveys, and even local maps and guide books, in a botanical library are brought together here for convenience in use. Fossil floras excluded from taxonomy would find place here.

WILLIAM TRELEASE.
MISSOURI BOTANICAL GARDEN.

ON THE CAUSE OF DARK LIGHTNING AND THE CLAYDEN EFFECT.

I HAVE been criticized in a letter which appeared recently in *Nature* for not alluding in my letter on dark lightning to the peculiar photographic reversal known as the Clayden effect. I must confess that at the time of writing my letter I was unaware of this effect, a description of which has only appeared, so for as I know, in one of the photographic journals. Mr. Clayden has certainly explained dark lightning, and it only remains to explain his explanation. As I think that this effect is not generally known, I believe that it may be worth while to devote a few words to the statement of the case, before describing the experimental work by which I have determined the factors which play a part in this very curious photographic phenomena.

Mr. Clayden showed that if a plate, which had received an impression of a lightning flash or electric spark, was subsequently

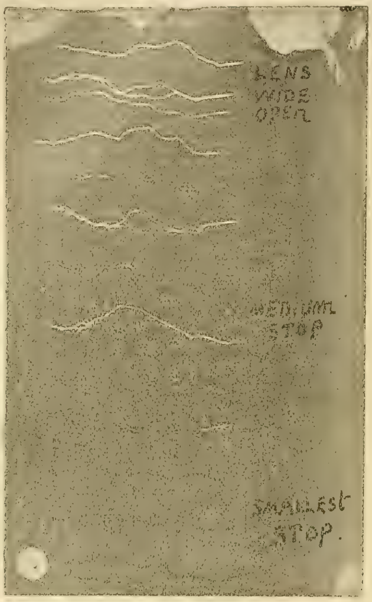


FIG. 1.


FIG. 3.

FIG. 4a.

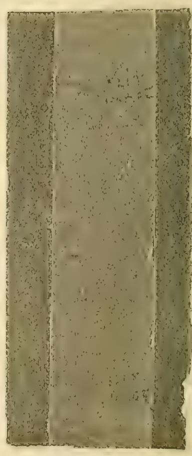


FIG. 5.

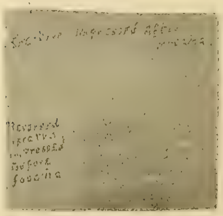


FIG. 2.

FIG. 4b.

slightly fogged, either by exposing it to feeble diffused light or by leaving the lens of the camera open, the flash on development came out darker than the background. If, however, the plate was fogged before the image of the flash was impressed, it came out brighter than the background, as in the ordinary pictures of lightning. I refer to the appearance in the positive print in each case. This is quite different from ordinary reversal due to the action of a very intense light, for the order in which the lights are applied is a factor, and the phenomenon lies wholly in the region of under exposure. I repeated Mr. Clayden's experiment, and obtained dark flashes without any difficulty.

The effect cannot, however, be obtained by impressing an image of a filament of an incandescent lamp on a plate and subsequently fogging the plate. Clearly there is something about the light of the electric spark which is essential to the production of the reversal. It is not intensity, however, for I found it was impossible to obtain reversed images or bright sparks with the lens wide open.

Fig. 1 shows a series of spark images, some normal, some partly reversed and others wholly reversed. The sparks are those of a large inductorium, with a good sized Leyden jar in circuit. The sparks were all of equal intensity, but after each discharge the iris diaphragm of the lens was closed a little. It will be seen that the borders of the bright sparks are reversed. In some the image is reversed with the exception of a narrow thread down the core. The images were impressed in succession on the plate by moving it in the camera. A plate holder was dispensed with, an opening being made in the ground glass back by removing a strip a few centimeters wide. The plate was held against this opening and a large number of exposures made in a few moments. Of course, the room was in total darkness. After exposure the plate was exposed to the light of a candle for a second or two and then developed.

In this series of pictures it will be seen that the edges of the bright images of the sparks are reversed, the intensity on the border of the image being less than at the core. As the intensity of the spark becomes less and less, the bright central core dwindles down to a mere thread and eventually disappears, the spark's image being feeble enough to reverse over its entire area.

This explains why the dark lightning flashes are usually ramifications of the main flash. The ramifications are less brilliant discharges and reverse, while the main one is too bright to cause the effect.

The first thing that occurs to one is that it may be some peculiar radiation which the spark emits, which is wanting in the light coming from other bodies. If a small photographic plate is partly screened by a piece of black paper and illuminated by the light of a small spark at a distance of two or three feet, and a similar plate, screened in the same manner, is illuminated for a moment by candle light of sufficient intensity to produce the same amount of blackening on development, we shall have the means of showing that the spark light differs in its action on the plate from that of the candle. If these two plates before development be half screened in a direction at right angles to the former one, and exposed to the light of a candle for a second or two, the part of the plate which has been illuminated by spark light plus candle light, does not become as black on developing as the part which has only received candle light, whereas the part which has twice been exposed to candle light is blacker than that which has been only exposed once. This shows that the light of the spark does not act in the same way as the light of the candle. Wherein does it differ? It seemed possible that the

peculiarity lay in the nature of its radiation. To test this a prism was placed before the lens of the camera which broke up the image of the spark into a series of spark images of different color. The plate was exposed to the spectrum flash of a single spark, then removed from the camera and exposed to the candle light, and developed. If the reversing effect was due to any peculiar radiation or wave length, we should find the reversal at the part of the spectrum where the effective radiation belonged, say in the infra red, if the reversing power lay in long waves given out by the spark. It was found that the entire spectrum came out lighter on the negative than the fogged background. A second plate was exposed to the spectrum flash, then slightly fogged, and a second spectrum impressed on it. On developing one spectrum came out light and the other dark, as shown in Fig. 2. Clearly the effect does not depend on wave length. It then occurred to me that the time element might enter into the problem. The light of the spark is over in about 1/50000 of a second and it did not seem impossible that a bright light of exceeding short duration might act quite differently on a plate from a weaker light of longer duration. This may be tested in a variety of ways. We may open the lens wide, impress the image of a single spark on the plate, and then stop the lens down and superimpose a number of spark images sufficient to make the total exposure the same in each case. This was the first method which I tried. In order to compel the successive sparks to pass over the same path, that their images might be superposed, I shut them up in a capillary tube. With the lens open wide enough to give the maximum reversing action, I passed a single discharge through the capillary. Stopping the lens down to one-quarter of its former aperture, four discharges were passed through the tube. The plate was then fogged in the usual manner, and on development the single discharge was reversed, but the composite one was not.

Fig. 3 is from a plate showing this effect. The upper images are those of single discharges through the capillary, with different apertures on the lens ; the lower images are those of double or triple discharges through the same tube. The left hand side of the plate was exposed to the candle light for different amounts of time, by moving the screen over small distances during the exposure. Only the single discharges reverse, though the density of the images on the unfogged portion of the plate is the same. This is very strong evidence that the duration of the illumination was the important factor.

Some years ago I measured the duration of the flash of the exploding oxy-hydrogen, finding it about 1/12000 of a second. Possibly the flash of such an explosion would duplicate the effect. I exploded several glass bulbs filled with electrolytic gas, but found that the action was the same as that of ordinary light, it being impossible to get any reversal. The flash evidently lasted too long, or there still remained some undiscovered factor.

The difference between the action of spark light and the light of the oxy-hydrogen flash is shown in Fig. 4. Plate 'a' shows the effect of the explosion flash. Squares 1 and 2 received the light from an exploding bulb, the rest of the plate being covered. Squares 1 and 3 were then exposed to the light of the candle. Square 1, which has received the light from both sources, is the brightest, that is, the effects are additive, there being no reversal. Plate 'b' shows the action of the light from the spark. Squares 1 and 2 were illuminated by the spark light, then squares 2 and 4 were exposed to the candle. In this case square 4, which was illuminated by the candle, is brighter than square 2, which received both the spark light and candle

light. In this case the effects are not additive, there being reversal.

To demonstrate conclusively that the time factor was the only one, it was necessary to secure an illumination independent of the electric spark, and of as short duration. This was accomplished in the following manner: A disc 30 cms. in diameter was furnished with a radial slit one millimeter wide near its periphery, and mounted on the shaft of a high speed electric motor. A second slit of equal width was arranged in a horizontal position close to the rim of the disc, in such a position that the two slits would be in coincidence once in every revolution. This second slit was cut in the wall of a vertical chute down which a photographic plate could be dropped. By means of a large convex lens of short focus an image of the crater of an arc-lamp was thrown on the point of coincidence of the slits. The intensity of the illumination transmitted by the slits when in coincidence was almost sufficient to char paper. The motor was then set in motion and a plate dropped down the chute. On developing this plate three images of the slit appeared, not at all overexposed, though the plate was the fastest on the market, and the intensity of the light while it lasted comparable to that at the focus of a burning glass. By measuring the distance between the images and the vertical distance through which the plate had fallen, it was an easy matter to calculate the speed of rotation, which was found to be 60 revolutions per second, the air friction of the disc preventing higher speed. The duration of the exposure will be the time occupied by the rim in traveling a distance equal to the width of the slit or 1 mm. This was found to be 1 / 55000 of a second about that of the spark. The crucial experiment now remained. A second plate was dropped and before development was exposed to the light of the candle. *The images of the slit were most beautifully reversed* except at the center where the light was too intense. A print from this plate is reproduced in Fig. 5. It seems then that we are justified in assuming that *the action of an intense light on a plate for a very brief time interval decreases the sensitiveness of the plate to light.* It is curious to contrast with this effect the fact that exposure to a dim light for a moment or two appears to increase the sensibility by doing the small amount of preliminary work on the molecules, which seems to be necessary before any change can be effected that will respond to the developer. I am not prepared to say what the nature of the change effected by the flash is. Possibly some one familiar with the theory of sensitive emulsions can answer the question. I have tried using polarized light for the reversing flash, and then fogging one-half of the plate with light polarized in the same plane, and other half with light polarized at right angles to it. As was to be expected there was no difference in the effects.

R. W. WOOD.

PHYSICAL LABORATORY OF THE
UNIVERSITY OF WISCONSIN,
MADISON, Oct. 20, 1899.

ARCHITECTURAL PLANS FOR THE UNIVERSITY OF CALIFORNIA.

THE Phoebe A. Hearst International Competition for an Architectural plan for the University of California was closed on September 7th by the awarding of five prizes for the best plans. The first prize was awarded to M. E. Bénard, of Paris; the second to Messrs. Howells, Stokes & Hornbostel, of New York; the third to Messrs. Despradelle & Codman, of Boston; the fourth to Messrs. Howard & Cauldwell, of New York, and the fifth to Messrs. Lord, Hewlett & Hull, of New York.

From the outset of their inspection, the judges were attracted to the drawings which proved, after the awards had been made, to

be those of M. Bénard. The jury had laid down four propositions for their guidance in the determination of the relative merits of the plans. These propositions were:

1st. That the buildings should represent a university rather than a mere architectural composition.

FIG. 1.—Perspective view of the plan for the University of California.

2d. That there should be a convenient grouping of the educational sections without undue crowding or prevention of possible future expansion.

3d. That the purpose of the several departments should be clearly defined in the design.

4th. That the architectural forms should be adapted to the configuration of the grounds and to the preservation of their natural beauties.

Judged by these standards M. Bénard's plan seemed to possess unquestioned superiority. Its great general beauty, its variety yet harmony of detail, its adaptability to the site, its convenience of arrangement, its flexibility and alterability in respect to individual buildings and to minor matters, and withal its permanent establishment of the great lines of its construction, placed it preëminently above all others. The jurors were unanimously of the opinion that it fulfilled nearly every requirement that might be demanded.

The site of the University at Berkeley, which the architect might utilize, comprises some three hundred acres of land, rising at first in a gentle and then in a bolder slope from a height of about two hundred feet above the sea level, to one of over nine hundred feet. Its greatest length is east and west. The southeast corner has a grove of beautiful indigenous oaks and laurels. Two brooks, which meet in this grove, come the one from the southeast, and the other from the northeast. Along the lines of these streams are native trees, principally laurels and live oaks. The eastern limit consists of a plateau of nine hundred feet elevation. Behind this rises a range of hills, which a mile further back reaches an altitude of nearly two thousand feet.

M. Bénard's plan preserves the park in the southeast corner intact. Adjoining this on the north is his group of buildings for the fine arts, formed around what he calls

Fine Arts Square. These buildings are the Academy of Music at one corner; the great Auditorium or Hall of Ceremonies, at the second corner; the smaller Auditorium, or Lecture Hall or Theatre, at the third corner; and at the fourth corner the School of Fine Arts. Between the School of Fine natural park. The Museum is the most beautiful building in the entire scheme. Fine Arts Square, with its buildings of a public nature, occupies the position most accessible to the town and trains.

Lying east of this group is the great group of educational buildings, divided into

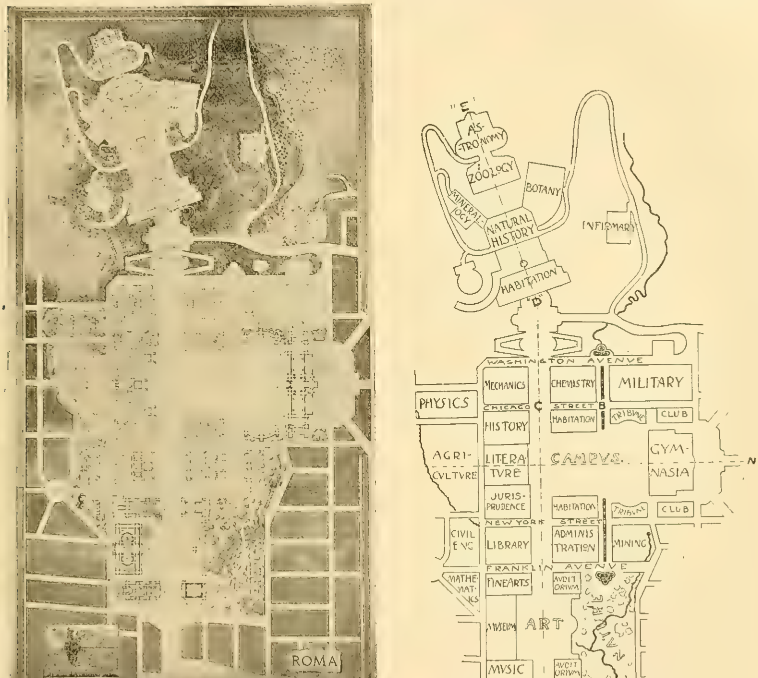


FIG. 2.—General plan and skeleton plan of buildings for the University of California.

Arts and the Academy of Music is the University Museum. This faces Fine Arts Square to the south. This square measures about six hundred feet each way. It connects, through a monumental arch balustrades, and grand flights of steps, with the three sub-groups. The first of these subgroups comprises, chiefly, the Library and the Administration Building, facing each other on opposite sides of a great avenue, University Avenue, which entering the grounds at Fine Arts Square, runs east-

ward till it reaches the steep ascent of the hills. The Library and Administration Buildings thus form a connection between the more public and the more private portions of the University.

The next sub-group is comprised of the principal college buildings, which we may call the College Hall or the Hall of the Humanities, two of the dormitories, the campus and the gymnasium. This occupies the space on the grounds which has the greatest breadth. It is monumental in character. The vast College Hall provides for philosophy, jurisprudence, history and political science, and ancient and modern literatures. This is treated as the centre of intellectual activity, and is marked by a dominating tower.

South of this College Hall is the extensive campus flanked first by two dormitories, then the Tribunes and closed on the south by the Gymnasium. The Gymnasium has attracted much attention, because M. Bénard chose it as the building in which to show the details called for in the programme of the competition.

The next sub-group lying east of the last, contains the departments of physics, mechanics, chemistry and military. These stretch along a plateau which will place them above the roofs of the college hall and other buildings of that group.

These groups of buildings, with some others to be mentioned later, cover the more gentle slopes of the site. We now come to a steep ascent. Near the bottom of this slope, above a garden, M. Bénard has placed two dormitories, and above these, a group comprising Zoology, Botany, Geology and Mineralogy and a Natural History Museum. And above all, crowning the landscape is the Astronomical Observatory.

In M. Bénard's scheme the building for Mathematics and Draughting is placed in a triangular spot behind the School of Fine Arts and adjacent to Civil Engineering, which is placed behind the Library. The Mining Building balances the Civil Engineering, by being placed behind the Administration Building. The Agricultural Department is placed in a field north of the main College Hall and increases the breadth of that magnificent group.

Now, it is to be said, that the location of the scientific departments will require in many cases to be changed or transposed. As they stand they indicate a fine conception on the part of M. Bénard, surrounding, buttressing and extending the educational domain. But he had naturally failed to observe the connection of related departments. Owing, however, to the flexibility of the plan, there will not be the slightest difficulty in making the modifications required.

Every building in the whole scheme is designed with a view to its use. The exterior architecture is simple or more or less ornate according to the purpose of the building. Each one asserts its identity by its appearance. Interiorily, again, they are arranged with the utmost precision in the ways indicated by the program. Lecture hall, laboratory, corridor, class-room, study, are all brought into proper relation.

With all the great number of buildings, and the size of them, there is no crowding. The two large spaces, the natural park and the campus, attest this. Besides, there are great longitudinal avenues, each with four rows of trees, and a third parallel avenue, four main cross avenues and numerous smaller streets and walks. The circulation is complete. Foliaged nooks and gardens abound. The whole scheme looks as free and open from a point of view of nature as it appears monumental from a point of view of architecture. M. Bénard has kept in mind, or has conceived unalterably, that he was designing a university, but that this university was a City of Learning.

William Carey Jones.
Department of Architecture,
University of California.

THE FOSSIL FIELD'S EXPEDITION TO WYOMING.

IN June last, the Union Pacific Railroad Company issued a large number of invitations to colleges, universities and museums doing work in geology, to participate in an exploring and collecting tour through the fossil fields of Wyoming, long famous for their remains of various extinct vertebrates. Free transportation was furnished by the railroads from Chicago and return, as well as from other northern and southern railroad centers, to Laramie, Wyoming. At Omaha, Mr. A. Darlow, for the Union Pacific Railroad Company, bade all welcome, looked after the comfort of the guests, and accompanied the expedition to Laramie. The party began to arrive in the latter place July 19th, that day being spent in the election of officers, and in the final preparations for camp life. In the evening, the élite of the university City of Wyoming gathered at the University, where President Smiley extended a cordial welcome to all.

Professor Wilbur C. Knight was elected president and director of the expedition. Wagons, tents, bedding, provisions, and other necessary articles for camping were furnished the members, and, as it afterwards proved, at less than the actual cost. The 'outfit' moved out of Laramie, July 21st, and consisted of 19 two-horse wagons and a few saddle horses, thus providing transportation for 85 men. The party was composed of 66 geologists, paleontologists, botanists, photographers and reporters, with 19 teamsters. Seven of the latter also officiated as 'camp cooks,' each of them purveying to a mess including generally 10 persons. The newspaper men were the first to drop out, and after the North Fork of the Platte River was reached, a little over twenty days out, the expedition was reduced to 14 men. These completed the tour of forty days, as originally planned by Professor Knight, and had a most profitable and enjoyable trip. During these 'forty days in the Wilderness,' we traveled upwards of 300 miles over the treeless, sage-brush plains of eastern Wyoming, and made 18 camps, sometimes besides an alkaline lake, but oftener by a small spring or stream. In this arid region it rained frequently during the first four weeks, and though the rains were generally light they greatly surprised us. On July 23d, we had a snow-balling and alpine flowers in the Medicine Bow Mountains, at an altitude of about 9,000 feet; while on August 11th and again on the 24th, ice formed.

Thirty-two institutions of learning and research, from California to Massachusetts and from Minnesota to Texas, were represented in this expedition which offered so great an opportunity for geological observation and study. Here could be seen plains 6,000 feet or more above sea level, some almost smooth and others more or less dissected, or several one above another all with the original bedding disturbed and tilted at an angle of from 10 to 30 degrees. Above these, in the distance, lay the Tertiary plateau, which to the eye is an absolute plain abutting against the granite mountains. Here and there over these plains are lakes, usually more or less alkaline, some without outlets produced by the solvent action of water percolating through the strata. At this great altitude could also be seen sluggish meandering streams with closely adjoining horse-shoe curves, the equals of any near the sea level. Towards the mountains the strata gradually stand more and more vertical in series, like so many stone walls, with the dike-cut granite not far away. On the plains, wind action could also be studied, sometimes in the linear arrangement of the sage brush, but frequently in the general polish and occasional faceting of surface pebbles and boulders. In general, the opportunity for studying geology could hardly be surpassed,

since much of Wyoming is one continuous exposure. After seeing this country, it becomes easy to understand how it was possible for a party of the Hayden Survey to prepare, in one field season, a reconnaissance map covering as many as 20,000 square miles.

The most interesting region of the trip, from a picturesque and geological standpoint, was that about the Grand Canyon of the North Platte. We first saw this from the high sage-covered Tertiary crest at 6,800 feet. Back of us were the rounded Indian Grove Mountains of granite, while long and dark Ferris Mountain stood on our left across the river. Directly in front was spread before us, like a painted stereoptican projection, the Grand Canyon country of the North Platte. The hills here have their escarpment directed towards the west, and are superposed like tiles on a roof. Beginning on our left were granite hills followed by those of Carboniferous, Triassic and Jurassic age, in places partially repeated, and all surmounted by the thick Tertiary lake beds. The colors of this panorama were pronounced and pleasing, especially when freshened by a rain, as when we first saw them. The brick-red color of the Triassic contrasted strikingly with the light green of the Jurassic and the browns of the Tertiary passing upwards into ash-colored beds. Hidden in this picture across the strike was the Grand Canyon of the Platte, eight miles long and in places nearly 1,000 feet deep. Over to the right may be seen the silver thread of the river issuing and flowing through the open country, but it is soon lost to view in the Little Canyon, which is 400 feet deep and about half a mile in length. Both gorges have perpendicular right-angled walls, and are very narrow, so narrow in places that a stone can be tossed across. Only one party is known to have gone through the Grand Canyon of the North Platte. This consisted of Freemont with Mr. Preuss and 'five of my best men,' Canadian voyageurs, who started in a canvas boat, August 24, 1842. The passage was extremely dangerous, and finally, at the foot of a fall, the boat was whirled over and men and baggage were thrown into the raging stream. Luckily no one was drowned, but most of the baggage was lost. In the Little Canyon, which is through a faulted ridge, there is a large hot spring that contains light-green algæ. This water is now piped half a mile to Alcova, where a pioneer has a primitive 'Hot Springs Resort' fifty miles from a railroad.

Another very interesting region was Bates' Hole, a narrow hole-like valley in Tertiary strata with a maximum depth of 1,500 feet. It is drained by Bates' Creek, a tributary of the North Platte, near Alcova. The lower level is in a series of delicately tinted yellow, red, green, and whitish Eocene shales and soft sandstones. Above, along the margin of the Hole, are the Titanotherium beds of the Lower Miocene, which are picturesquely castellated, series above series, in places 400 feet or more high. This constitutes another style of 'Bad Land' scenery. Here Professor Knight made use of an unusual method for ascertaining the time required for the erosion of Bates' Hole. The marginal slopes are often very steep, and upon them are growing isolated slowly dying pines perched by their roots from one to three feet above the present surface. Since the annual growth rings of the trees will indicate their age, a time measure is at hand for the amount of strata removed from beneath the tree. This, when taken in connection with the size of the Hole, will give some idea as to its age. A provisional estimate places it at 1,584,000 years since the close of Miocene time. (See Science, for October 27, 1899.)

Several tons of good fossils, mainly invertebrates, were collected during this trip.

Many of the members also expected to secure a Dinosaur each, but the magnitude of the work soon changed enthusiasm into regret. In the very beginning, alarming setbacks are encountered when climbing the hills in any direction for a 'bone lead.' Having the good fortune to discover one, the real work then begins in the digging, only to find that every bone is cracked into innumerable pieces. These must be bandaged and set in plaster, and when all is hard the bones can be turned to undergo more bandaging. This means that one must have patience, be expert with pick and shovel, with gunny sacking and plaster, and with saw and hammer. However, with all these difficulties to overcome, no less than six car loads of bones were shipped this summer from Medicine Bow, a little village on the Union Pacific Railroad in Wyoming, by specially organized parties from the Universities of Wyoming and Kansas, and the Field, Carnegie and American Museums of Natural History.

In no one place are complete Dinosaur skeletons found. Sometimes a 'quarry' will yield a lot of vertebræ, or a number of either hind or fore limbs, or there is a general mixture of parts of animals of different genera. To make an adequate collection of Jurassic Dinosaurs, therefore, requires several successful field seasons. The cost is still further enhanced since in the laboratory the bones must be cleaned, hardened and restored before they are ready for study and exhibition. On account of these conditions and the further one that Dinosaur skeletons are very large, the work is extremely expensive. We can, therefore, believe that the best skeleton of Brontosaurus in Professor Marsh's collection, an imperfect one, cost him $10,000.

The wonderful newspaper stories of last spring about the finding of a Dinosaur indicating a length of 130 feet is the prize paleontological story of the season. The "ghoul of science, Mr. Reed" outdoes Stockton when he writes "that the animal now being brought to light weighed in life about sixty tons, that he had a neck thirty feet in length, and a tail perhaps sixty feet in length. His ribs are about nine feet in length, and the cavity of his body with the lungs and entrails out, would have made a hall thirty-four feet in length, sixteen feet in width, and arched over probably twelve feet in height. A round steak taken from the ham of the animal would have been at least twelve feet in diameter. * * * A set of fours in cavalry could easily have ridden abreast between his front and hind legs, provided he had not objected. Every time he put his foot down it covered more than a square yard of ground and must have fairly shaken the earth. * * * When we get it here we shall probably place it temporarily in the campus * * * and we shall work as rapidly as possible in restoring our great prize to a normal condition here at Larmie." This wonderful story is based on two little holes in the Freeze Out Hills, which required about a day to dig. When all is exhumed, if there is anything to exhume, it will be found that 'our great prize' is after all but a normal Dinosaur. The excitement produced by the story, however, has another side, and a good one, since it led our newest Museum to take up the making of a collection of extinct monsters.

One of the great needs for geological work in Wyoming is good maps. Those available this summer were very poor; therefore nothing was attempted in the way of preparing geological maps.

In addition to the collections made and the individual 'experience' the expedition secured a number of new species of invertebrates. They located two new leaf horizons in the Fox Hills formation, a limestone with an abundance of fossils in the Red Beds supposed to be of Triassic age, and an-

other abounding in fresh-water shells together with turtle and crocodile remains in the Jurassic Dinosaur beds. On the basis of the fossils collected this summer, the Carboniferous of Shirley Basin and the Grand Canyon of the North Platte are to be correlated with the Madison limestone of the Yellowstone Park. The Carboniferous at 'Specimen Hill,' near the ranch of John Burnett in the Little Medicine settlement, is, however, of Upper Carboniferous age.

Game at times was plentiful. On the plains, we saw daily from a few to as many as fifty antelope, but we rarely got nearer to them than a half mile. Sage hens were also abundant. In the mountains, two species of grouse were seen. Beaver dams we saw only in the region of Larmie Peak. Coyotes were noticed daily and nightly we never failed to hear their broken-voiced barking. Bears and mountain sheep were not seen, but occasionally we came across their tracks. Jack-rabbits were not common, eagles very scarce, and but four rattlesnakes were killed.

In conclusion, it is believed that the sentiment of the members of the Fossil Field's Expedition is voiced when it is stated that we were particularly fortunate in having Professor Knight as chief geologist, leader, and quartermaster. He did his work well, and we are the gainers in making his acquaintance.

"The Dinosaur, King of the mountains,
The largest of all vertebrates ;
When he drank he exhausted the fountains,
And no one can tell what he ate.
He went about in the Jurassic,
And he'll never come back any more ;
His bones lie here in Wyoming.
Three cheers for the old Dinosaur."

Vincent, Coe College.

Charles Schuchert.

U. S. National Museum,
October 26, 1899.

SCIENTIFIC BOOKS.

THE 'THETA-PHI DIAGRAM.'

The Entropy-Temperature Analysis of Steam-Engine Efficiencies. By Sidney A. Reeve. New York. 1897. 8vo. Pp. 20, with folded diagram.

The Theta-Phi Diagram practically applied to Steam, Oil, Gas and Air-Engines. By Henry A. Golding. London, Manchester and New York. 1898. 12mo. Pp. 127.

The Entropy-Diagram and its Applications. By J. Boulvin. Translated by Bryan Donkin. London and New York. 1898. Pp. 70.

The 'temperature-entropy diagram,' the 'theta-phi diagram,' as some recent writers, following Macfarlane Gray, are coming to denominate it, was suggested, somewhat indefinitely and without illustration of its applications, by Belpaire, in 1872; by J. Willard Gibbs, in a very definite form and with clear statement of the uses to which such a diagram may be applied, in 1873–1878, and by later writers in increasing numbers and with as steadily increasing extent and usefulness of application, particularly in the treatment of the theory of the ideal heat-engines and in their comparison with the real engines of daily life. About 1889 Macfarlane Gray presented papers to the British Institutions of Naval Architects, of Civil and of Mechanical Engineers, in which he employed the diagram in 'the rationalization of Regnault's experiments on steam' and other work so skilfully and effectively that the attention of his profession was then called to the then novel device, with the result of its permanent introduction into the current methods of thermodynamics, pure and applied. It was subsequently used very extensively by Willans in the discussion of the efficiencies of his engines, as exhibited by a series of famous trials which were brought to an abrupt termination by the early death of that talented engineer; although supplemented with great ability by his coadjutor, Captain Sankey. Boulvin, Ewing, Donkin and Cerry have since introduced this method of discussion of efficiencies and wastes of the heat-engines into treatises on those machines and their theory, and it may be now safely assumed that the system of Gibbs and his contemporaries in its development has become fully established

as a correct and a fruitful method of discussion of thermodynamic problems and phenomena.

A number of books and papers in elaboration of this system have recently appeared, and of these we take up several for review together. The titles of papers in the list given in the footnote* are added as containing the earliest and most important applications of this method of study of the efficiencies of the heat-engines, and the latest addition to the algebraic discussion of the abstract theory of entropy-diagrams.

The little book issued by Professor Reeve contains one of the clearest and most complete explanations of the temperature-entropy diagram that we have met with. The purpose of the publication is the presentation of a new diagram in which the author has introduced some modifications of the form proposed by Boulvin and, as it is thought, thus made the work of preparation for entropy-temperature analyses much less troublesome than formerly; obviating the necessity of detailed computations for each analysis. With this diagram at hand, it is thought that "the entropy method, once understood, will be found to reveal with surprising speed and facility factors in steam-engine economy hitherto only to be estimated, at best, and that only at the expenditure of tedious labor." This paper was originally published in the interests of the engineers; but it cannot fail to have equal interest and value for those engaged in the study of mathematical physics and abstract thermodynamics. The diagram is well made, its explanation is admirably satisfactory, and the text is printed with equal excellence. The diagram consists of a sheet divided into four quadrants, of which one is devoted to quantities involving pressure-temperature determinations, the second to those related to entropy-temperature problems; the third gives entropy-volume quantities, and the fourth pressure-volume measurements. On these four sections of the sheet are laid down with care and accuracy the corresponding curves for water and steam, unity-weight in each case, and printed upon the sheet are also the heads for entries of all necessary data from observation at an engine trial, in the reduction of which this method is to be employed. The method of use of the system and of the diagram in its applications to heat-engines is very fully and lucidly described and illustrated.

The chart and its text will, unquestionably, be found to be very useful and helpful to every engineer seeking to enrich his work by the results of this system of exploration of the thermodynamic and the thermal and the dynamic phenomena of heat-engine performance.

Mr. Golding's 'Theta-Phi Diagram' and its illustrations of practical application of the Gibbs system of treatment of thermodynamic problems also find place in the work of the engineer employed in the investigation of the performance of engines, whether the working fluids be steam, gas, air or oil-vapor. The author employs geometrical rather than algebraic methods, where choice is allowed; illustrating the fact which will probably be observed by all familiar with the matter, that the designer and constructor, the mechanic in whom the art is inborn, is almost invariably a geometrician rather than an algebraist. The utility of the method presented is considered beyond doubt, and, as Mr. Robinson remarked in discussing a paper by Mr. Willans, whose disciple, Mr. Golding, evidently is, "Up to a certain point, the practical man might ignore the present paper and others like it; but if he aspires to design economical engines, he might derive more good from the study of, say, Mr. Macfarlane Gray's 'Theta-Phi Diagram' than from many portfolios of working drawings." In fact, the study of current practice, in working drawings, simply reveals the relative forms and proportions of well- and ill-designed engines and throws little light upon the causes and remedies of faults of construction or defects of practice. The author acknowledges indebtedness to the earlier writers, Boulvin,

* Belpaire, Th., 'Bulletin de l'Academie royale de Belgique,' 1872. Gibbs, J. Willard, 'Trans. Conn. Academy of Arts and Sciences,' 1873. Linde, C., 'The Refrigerating Machine of To day'; Trans. (Munich, 1875), A. S. M. E, 1893. Gray, Macfarlane, 'Trans. Inst. Naval Archts.,' 1889; Inst. C. E., 1889; Inst. Mech. Eng'rs., 1889. Willans, P. W., 'Steam-Engine Trials'; Minutes Proc. Inst. C. E., 1888–1893. Sankey, H. R., Proc. Inst. M. E., 1891; Proc. Inst. C. E., 1895–6. Durand, W. F., Jour. Am. Soc. Naval Engineers, May, 1898, Sibley Journal, 1898.

Gray, Willans and others; but he is himself certainly entitled to the thanks of the scientific and the practical worker in the field of thermodynamics, pure and applied, for the extent to which he has developed his theme, and for the excellence of his own work. The information given by Mr. Golding had hitherto been scattered through various technical periodicals and transactions of learned societies, often quite inaccessible to the average practitioner, and its collection into a formal and logical treatise is a veritable boon to the student of heat-engine-efficiencies, whether as scholar, simply, or as practitioner of the art of engine-design and construction. The text is clear and well-written, and the profuse illustration and excellent engraving throughout the book are worthy of all praise. The tables, so far as we have checked them by differences, seem accurate and the diagrams are remarkably well-selected as illustrations of the facts and principles involved in the discussion. Boulvin's diagram is introduced as the 'complete entropy-diagram' and its use is well-explained and illustrated.

The entropy of water and of steam are computed and tabulated; the standard engine-cycles and their details are discussed; the effects of jacketing and compounding the steam-engine and those of superheating and of initial condensation are studied; the conversion of indicator to entropy-diagrams is shown and the thermodynamics and physics of the steam-engines are treated at ample length. Similarly complete discussions of the air, gas and oil-engines are presented and many novel applications of the system are shown. The book, as a whole, is an admirable presentation of its subject. A valuable feature is a new table of the weights of saturated steam per cubic foot, for each one-tenth-pound pressure, up to 219, with differences computed for each one one-hundreth or a pound per square-inch.

Professor Boulvin's work, as translated by Donkin, is that of a master in the new art. Its author was one of the first to appreciate and to take up the Gibbs' system of thermodynamic discussion and incorporated it into his work on the steam-engine, published in 1893. The present work appeared in the *Revue de Mécanique* in 1897, and, at the request of Mr. Donkin, who offered to make the translation into English, the author consented to reproduce the discussion in book form. It is, as the translator says: "A short syllabus of the principles of thermodynamics as applied to heat-engines and its chief claim to originality lies in its systematic method of using temperature-entropy diagrams." The author deduces a 'heat-balance' from the data of a steam-engine trial, by the employment of the theta-phi chart in a very simple and direct manner, and avoids the lengthy and troublesome computations necessary in the algebraic system of Hirn. The older systems were incomplete; the present is practically perfect in many points in which the others were defective. The 'complete entropy-chart' of Boulvin is especially useful in this work. The Boulvin diagrams and chart afford a means of not only making a heat-balance, but also of following the movements of heat throughout the cycle, and this without other computations than those required in reducing to scale the quantities to be dealt with. As observed by the translator: "The best standard of efficiency for the steam-engine has been much discussed and the question would be practically solved if, for every steam-engine, we had entropy-diagrams, all traced to the same scales of entropy and temperature for a unit-weight of steam coming from the boiler. These diagrams could be compared with each other, and in any country, and the smallest variations in the work of each engine graphically shown without any explanation being necessary." In this publication, Professor Boulvin has added a new method of dealing with clearances and throttled steam; ascertaining the action of the walls of the cylinder in heat-exchanges, and representing it in all cases independently of the extent or character of compression. The weights and measures employed are in this work entirely metric and the student can thus find in the last-named two treatises opportunity to compare the same methods, employing these different symbolic and measuring systems for similar purposes.

The plan of the book is thoroughly systematic, commencing with a study of the funda-

mental laws of thermodynamics, giving the relations between temperature and entropy, the study of cycles, entropy computations, applications to vapor and gas-engines, and closing with elaborate illustration in discussion of the results of a steam-engine trial. The discussion of the physics of steam by this method is particularly complete and valuable and the tables appended will be found useful on many occasions. Within the sixty-six pages of text there are to be found abundance of suggestions and instruction and the whole is written in a thoroughly scientific and systematic manner, without waste of words or loss of energy in diffuse explanation.

It should be noted by the readers of these little treatises that, occasionally, in the diagrams, an error will be noted in the assignment of a quantity of entropy to a mixture of steam and water less than that of water alone.

The interested reader of this collection of brochures should complete his work, if not already familiar with them, by examining the added list of papers. Professor Gibbs, as the real pioneer in the use of this interesting method, Linde as the first to apply it to the refrigerating machine, Gray as the writer whose enthusiastic and painstaking elaboration of the system first brought it to the attention of engineers in such a manner as to insure its careful examination and later general use, Willans, the pioneer in its application as a regular process of reduction of observational data to form for deduction, and Sankey, his co-laborer, also, are entitled to distinction only less than that accorded to the founders of the science which this system illustrates. Professor Durand, illustrating talent as an instructor as well as familiarity with the state of the art to date, presents the most complete and intelligible exposition of the theory of the entropies—for he shows that there may be an indefinite number—and, availing himself of suggestions by Ancona in a very notable paper in the *Zeitschrift* of the German Society of Civil Engineers for 1897, produces diagrams which are read with great ease and interpreted as readily. This is a luminous and clear as well as concise exposition of the subject.

R. H. THURSTON.

Alternating Currents of Electricity and the Theory of Transformers. By ALFRED STILL. Whittaker & Co. 8vo. 1898. 179 pages.

Alternate Currents in Practice. Translated from the French of Loppé and Bouquet by F. J. MOFFETT. Whittaker & Co. 8vo. 1898. 372 pages.

In the application of science to engineering the scientific principles involved have usually been very fully developed beforehand by the student of pure science. In the engineering applications of alternating currents, however, our educational and scientific men have been behindhand. The fundamental mathematical principles of alternating currents have indeed been developed mainly by men outside of the engineering profession, as exemplified by the epoch-making book of Bedell and Crehore, but the theory of actual engineering apparatus, such as the transformer, the rotary converter, the induction motor, etc., has been developed mainly by the engineer, and during the past few years our electrical engineering instructors have been looking eagerly to the manufacturing electrical engineer, not only for the details of design and construction, but also for the full and complete theory of their machinery as well. The engineer who has contributed most in this line is perhaps C. P. Steinmetz.

The electrical engineering instructor has now access to literature containing very complete developments of fundamental principles and very complete theoretical analysis of actual engineering machinery, and the problem which confronts him is to adapt this wealth to the requirements of instruction.

Instruction in electrical engineering should consist of two parts, as it seems to us, namely, an elementary part in which the general principles of the various branches of the subject are systematically developed, and a more practical part devoted to the design, construction and operation of machines, appliances and installations. In some branches of electrical engineering, indeed, the elementary part is little more than a course in theoretical electricity, but in alternating currents a great variety of principles arise which are not properly included in any general course in electrical theory, and it seems proper for the student to

be taken through a course of study in the analytical theory of the alternator, the transformer, etc., before beginning the practical study of alternating current appliances.

The separation of theoretical and practical treatises seems to us to be highly desirable, for our experience is that nothing obscures an elementary treatise (that is, the elementary part) so much as the introduction of practical matter not needed for purposes of illustration, and we conceive that nothing is so annoying to a well instructed engineer as to have his engineering literature highly diluted with elementary matter.

Alternating Currents, by Alfred Still, is an excellent, clean cut, elementary treatise. Pages 1 to 116 are devoted to the general principles of alternating currents and the remainder is devoted to the theory of the transformer. In reading this book one has a desire to know what the author might have to say of the synchronous motor and rotary converter, and of the induction motor, so simply and satisfactorily is the theory of the transformer worked out. One cannot of course judge whether or not the author realizes the paramount importance of these machines and the need for a simple exposition of their theory.

In speaking of the expression $B=\mu H$ the author says that "the point which is not generally clearly explained is that there is no necessity whatever, to consider the iron core removed, or even to imagine longitudinal holes drilled through the mass of the iron in order to understand what is meant by H in the above relation." However, we do not know what actually takes place *in* magnetized iron and in the specification of the state of magnetization of a rod we can, and do, specify only what is happening outside the rod or in holes drilled through the rod.

In speaking of magnetic leakage the author devotes his attention mainly to that case in which the *trend* of the useful magnetic flux would be but little altered by the removal of all iron parts the flux being, of course, reduced in value. In this case the magnetic leakage generally decreases with increasing excitation. The most frequent case in practice, however, is that in which the *trend* of the useful flux would be greatly altered by the removal of the iron parts, as for example in the dynamo. In this case the magnetic leakage increases with increasing excitation.

Mr. Still's book "has been written not only for engineering students, but also for those engineers who are but slightly acquainted with alternating current problems." We cannot agree with the author that for this class of readers analytical methods are unsuitable for the solution of alternating current problems. The engineer who attempts the graphical method soon finds it to be impracticable except only as an aid in the formulation of analytical solutions. Steinmetz' method seems to us to be the simplest method for obtaining numerical results and the only method to be called practicable.

Alternate currents in practice, translated from the French by Francis J. Moffett, is a good discussion of a great variety of practical alternating current apparatus with comparatively little useless or misplaced elementary matter. Mr. Moffett says that to the best of his knowledge there is no work in existence in England at the present time which treats in a practical manner the whole range of alternating currents of electricity and we do not know of any such work in America for the admirable works of Bedell, Jackson and Steinmetz are distinctly theoretical.

W. S. FRANKLIN.

Das Tierreich Sporozoa. By ALPHONSE LABBÉ. Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. Herausgegeben von der Deutschen Zoologischen Gesellschaft. 5 Lieferung. Protozoa, Sporozoa. Berlin, Friedländer & Sohn. 1899. Pp. xx + 180.

As indicated by the descriptive title of Das Tierreich, a zoological dictionary of which Franz Eilhard Schultze is the chief editor, it is no part of the undertaking to give a general account of the classes of animals considered, but merely recognizable descriptions of all known species. For the present volume—the Sporozoa—a better man than Alph. Labbé could not have been chosen, and, so far as the sporulation is concerned and the determination of species through spores, or the hosts of the

parasites, the location within the hosts, or the bibliography of each species, the book is eminently successful. Apart from the Gregarinida where the descriptions are more complete, a criticism might be justly made against the extreme brevity of the specific descriptions, especially where they deal with the adult organisms. For example, an adult form of the genus *Coccidium*, the sporulation of which is given for 17 species besides numerous varieties, is nowhere described. Of course the sporulation is the more important and the omissions are more than offset by the splendid bibliography which accompanies each specific name. One hundred and ninety-six figures, for the most part of spore-stages, accompany the descriptions.

In accordance with the rules of nomenclature adopted by the Deutchen Zoologischen Gesellschaft, the names of legions end in IDIA, the names of orders in IDA, of sub-orders, in INA, of tribes, in EA, of families in IDAE, and of subfamilies in INAE. It is a relief to feel that, in the future, there will be no excuse for such haphazard terminations and names as have characterized the Sporozoa groups heretofore.

The classification adopted by Labbé is based, in its main divisions (legions and orders) upon his classification of 1894. The two legions are the *Cytosporidia* and the *Myxosporidia* (his *Histosporidia* of 1894), the former containing four orders: *Gregarinida*, *Coccidiida*, *Hæmosporidiida*, and *Gymnosporidiida;* the latter, two; *Phænocystida* and *Microsporidiida*. *Sarcosporidia*, *Amœbosporidia* and *Serumsporidia* are placed as Sporozoa *incertæ sedis*, the terminations indicating legion-value. Delage and Hérouard's suborders of the Gregarinida are adopted (*Cephalina* and *Acephalina*), while the tribes and families are adapted from Léger. He follows his own classification of the *Coccidiida*, dividing them into two sub-orders: *Polyplastina* and *Oligoplastina*, the former into two tribes: *P. digenetica* and *P. monogenetica;* the latter into three tribes: *Tetrasporea*, *Trisporea* and *Disporea*, while family-groupings are discarded. It is to be noted that the single form in the tribe *Trisporea* is his very questionable genus *Bananella*, which Léger and others regard as an anomalous type of a four-spored (*Tetrasporea*) form, and which Labbé himself admits may sometimes ('*accidentellement*') have four spores. The *Hæmosporidiida*, without further sub-divisions, contains the three genera *Lankesterella* (Labbé), *Caryolysus* (Labbé) and *Hæmogregarina* (Danilewsky). The *Gymnosporidiida*, without further sub-divisions, contains six genera: *Caryophagus* (Steinhaus), *Halteridium* (Labbé), *Hæmoproteus* (Kruse) *Plasmodium* (Marchiafava & Celli), *Laverania* (Grassi & Feletti *em.* Labbé), and *Cytamœba* (Labbé). For the terminology of the Malaria-organism (*Plasmodium*) which was first recognized by Laveran in 1880 and, in 1883, named by him *Oscillaria malariæ*, Labbé takes the generic name applied to it in 1885 by Marchiafava & Celli, and Laveran's specific name, thus giving the Malaria organism the somewhat unfamiliar name of *Plasmodium malariæ*. On the ground of priority this name must supplant the, in some respects better, term *Hæmamœba*, given by Grassi & Feletti in 1890, with the advantage, however, of a more descriptive specific name in *malariæ*, than has hitherto been known in Labbé *laverani*. On the whole, therefore, the new name *Plasmodium malariæ* is fully as good as the one it supersedes—*Hæmamœba laverani*. Labbé now makes two certain sub-species: *P. malariæ tertianum* (Golgi) and *P. mal. quartanum* (Golgi), and two questionable sub-species: *P. mal. præcox* (Grassi & Feletti) and *P. mal. immaculatum* (Grassi & Feletti).

Of the four families of the *Myxosporidia*, three belong to the order *Phænocystida* (*Myxinidæ*, *Chloromyxidæ*, *Myxobolidæ*) and one to the order *Microsporidiida* (*Nosematidæ*).

The volume contains a well-arranged list of the hosts of Sporozoa with the organs affected, while a key to families and genera, and in most cases to the species, will materially assist the student in placing forms.

Taken, as a whole, the volume is a very welcome addition to the literature of the Protozoa.

GARY N. CALKINS.

COLUMBIA UNIVERSITY,
NEW YORK CITY, October 30, 1899.

Leitfaden für das zoologische Praktikum von DR. WILLY KÜKENTHAL, Professor in Jena. Mit 172 Abbildungen im Text. Jena, Verlag von Gustav Fischer. 1898.

This guide consists of an 'Introduction' of four pages on instruments and general directions followed by eleven pages on the 'Elements of Histology' and 269 pages on the various groups and types of animals.

The list of animals named for special study represents 76 genera and 83 species—a list that indicates the author tried to live up to the statement in the preface that the zoological laboratory of to-day does not simply offer a few local types for dissection, but rather constitutes a practical 'Repetitorium' of the fundamental facts of zoology.

The work is divided into 20 'courses' distributed among the nine phyla recognized as follows: Protozoa (pages 15), Platodes (7), Echinodermata (21) and Tunicata (14), each one course; Vermes (Bryozoa, Chætognatha, Annelida) (28), Mollusca (37) and Arthropoda (29), each two courses; Cœlenterata (43) four courses and Vertebrata (76) five courses. The first course is devoted to Elements of Histology.

Each course or group of courses is preceded by a 'Systematischer Ueberblick' of the phylum in which the classification is carried out to the orders and suborders. In this systematic epitome each category is more or less briefly characterized and one or two representatives are noted under each order or suborder. This is followed by a bit of technique, this by a general survey and this by the 'special course.' The treatment of the Coelenterata may serve as illustration of the plan. In this group the order is as follows: (1) 'Systematischer Ueberblick' of courses 3–6, (2) 3 Kursus (pp. 34–43). (3) Porifera. 'Technische Vorbereitungen.' (4) A. Allgemeine Uebersicht. (5) B. Specieller Kursus. (6) 4 Kursus (pp. 43–55). Hydroidpolypen. Technische Vorb., etc., as (4) and (5). (7) 5 Kursus (pp. 55–65). Tech., etc. (8), 6 Kursus (pp. 66–73). Anthozoa, Tech., etc. The general account of the phylum is brief and the 'special course' is a running account of the anatomy of the laboratory specimen with directions for dissection introduced whenever deemed necessary.

The reviewers experience is not favorable to the introduction of systematic and general surveys into a laboratory guide, and why a general account of a phylum should be preceded by a special technique is not clear to him. There are sound pedagogical reasons for logical order and for keeping a laboratory guide to its business.

As a laboratory guide for a beginner the book is not detailed enough and can hardly stand with such guides as those of Marshall and Hurst, Parker and others in English.

The illustrations, of which there are 172, are as a rule good. Quite a number of them, about 75, are original. Some of these could be improved. Figure 152, for example, would hardly assist a beginner in his search for the uterus or the bladder of the frog. It would also be uncertain work for a beginner to identify the ovary of a young frog either by the figures or the descriptions. On the whole, however, the original figures are good and welcome. The typographical work is of course neat, clean and agreeable —for it comes from the establishment of Gustav Fischer.

HENRY F. NACHTRIEB.

BOOKS RECEIVED.

Leçons de chemie physique, professées à l'université de Berlin. J. H. VAN'T HOFF. Translated from the German by M. CORVISY. Second Part, *La statique Chemique.* Paris, Hermann. 1899. Pp. 162.

Leçon nouvelles sur les applications géométriques du calcul différentiel. W. DE TANNENBERG. Paris, Hermann. 1899. Pp. 192.

Recherches expérimentales sur les oscilations electriques. A. TURPAIN. Paris, Hermann. 1899. Pp. 152.

Biological Lectures from the Marine Biological Laboratory, Wood's Holl, Mass. Boston, Ginn & Co. 1899. Pp. 343.

Animal and Plant Lore. FANNY D. BERGEN. Boston and New York, published for the American Folk-Lore Society by Houghton, Mifflin & Co. 1899. Pp. 180.

Evolution by Atrophy. J. DEMOOR, J. MASSART and E. VANDERVELDE, translated by MRS. CHALMERS MITCHELL. New York, D. Appleton & Co. 1899. Pp. xiii+322.

SCIENTIFIC JOURNALS AND ARTICLES.

THE principal article in the *National Geographic Magazine* for November is on 'The Alaskan Boundary,' originally given as a lecture before the National Geographical Society by Hon. John W. Foster, ex-Secretary of State, and at present a member of the Joint High

Commission. The paper presents the most complete summary of the Alaskan boundary dispute thus far made. Mr. Foster states that the dispute really dates from 1898, when it was presented without previous warning before the Joint High Commission which had assembled in Quebec. A number of maps which are offered as testimony show that on all the principal English maps the boundary line is as given on the American maps. Professor Alfred P. Dennis concludes his description of 'Life on a Yukon Trail,' begun in the October number. An article by Professor W. M. Davis, of Harvard University, on 'The Rational Element in Geography,' is the first of a series on methods of teaching and studying geography. There has been a steadily growing demand in the last few years for the better teaching of geography, and as earnest an effort on the part of many teachers to meet that demand. The *National Geographic Magazine* proposes to aid the work by presenting in its pages a series of articles by those most fitted to speak—able geographers who are also teachers of renown. The article by Professor Davis will be followed by a second from him on field and laboratory methods of teaching geography. Commissioner Harris, of the Bureau of Education, will treat the subject in several of its aspects, and a number of other equally prominent educators have promised articles which are to appear in the magazine within the next few months.

THE Chicago University Press has added to its publications the *Manual Training Magazine*, the first number of which was issued on October 1st. It is edited by Mr. Charles A. Bennett, of the Bradley Polytechnic Institute, Peoria.

SOCIETIES AND ACADEMIES.

THE NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY AND PHYSICS.

THE first meeting since the spring of the Section was held on 2d October, 1899, at 12 West 31st Street. Professor William Hallock read a paper on 'Compound Harmonic Vibrations of a String.' He said that some German experimenters have determined experimentally by photography the motions of different points of a vibrating string. The vibration varies, of course, according to the part of the string bowed, the speed, the kind of bow, etc. His paper, however, consisted essentially of a set of curves, calculated from the theoretical formulæ, showing the successive positions of a string vibrating under the influence of a fundamental and the first seven overtones. Each curve shows the position of the string at a particular instant. Sixteen such curves are shown for the first sixteen sixty-fourths of a complete period of the fundamental. The amplitude of the component is proportional to the wave-lengths, in each case. Thirty-two points were computed for each curve. Each curve is computed from the formula

$$y_1 = a \sin 2\pi \frac{t_1}{T_1} \sin 2\pi \frac{x_1}{l_1}$$
$$+ b \sin 2\pi \frac{t_1}{T_2} \sin 2\pi \frac{x_1}{l_2} + \text{etc.} \cdots$$
$$+ h \sin 2\pi \frac{t_1}{T_8} \sin 2\pi \frac{x_1}{l_8},$$
$$a = 2b = 3c = 4d = 5e = 6f = 7g = 8h,$$
$$T_1 = 2T_2 = 3T_3 = 4T_4 = 5T_5 = 6T_6 = 7T_7 = 8T_8.$$

In the discussion Professor Pupin said that it would be interesting to photograph the vibration of a string loaded, and also unloaded. Such a study might help our theories of electrical waves along a cable.

WM. S. DAY,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting of October 16th, after Mr. Geo. F. Kunz, the Chairman, had exhibited certain specimens, the regular paper of the evening was presented by Professor J. J. Stevenson on 'The Section at Schoharie, N. Y.' The Schoharie Valley is an indentation in the Helderberg Mountains, about 35 miles southwest from Albany, N. Y. It is of interest as showing a section from the Hudson to the Hamilton, with almost continuous exposures at various localities. This was examined during last summer with the view of making comparisons with conditions observed in parts of the Appalachian region within Pennsylvania and Virginia. There are some notable contrasts between the northern and the southern sections. At Schoharie, the Medina is wanting

and the greenish shales of Clinton rest on the Hudson. In southern Pennsylvania and in Virginia, the red and white Medina are both present and Hudson forms pass upward into the red Medina, occurring abundantly in southwest Virginia in a bed only 100 feet below the white Medina. At Schoharie, the Niagara is differentiated physically from the overlying Waterlime, but much of the Niagara fauna passes into the Waterlime ; in localities further west and south, the Salina shales intervene and there is no passage of fauna. The upper Waterlime at Schoharie differs greatly in color and composition from the Tentaculite or lower divisions of the Helderberg, but at least two forms, most characteristic of the Tentaculite, are found in the upper Waterlime. These forms were not observed by the writer in the Waterlime of southern Pennsylvania. The several sub-divisions of the Helderberg are very distinct physically, the boundaries of each being sharply defined ; but the physical changes were such as to cause only gradual disappearance of the several faunas and forms, which persist throughout, showing little variation. The passage from Helderberg to Oriskany, at Schoharie, is abrupt to the last degree—from a very good limestone to a ferruginous and only slightly calcareous sandstone. The faunal change is as abrupt as the physical. Here again the contrast is very great, for, in southern Pennsylvania, the passage from Helderberg to Oriskany is very gradual through a silicious limestone, containing forms belonging to each. In southwest Virginia the upper part of the Helderberg becomes silicious and in some localities is almost a sandstone.

In response to a request from the Chairman for notes on geological observations during the last summer, Professor Kemp reported on the progress of his geological survey of the Adirondack region. One result was the recognition of a true quartzite of pre-Cambrian date, affording thus a fragmental sediment. The sedimentary rocks in the region he found to be widely charged with graphite, indicating an abundance of organic life in pre-Cambrian time. Further types of eruptive rocks had also been identified, to fill up gaps in known series.

Professor Osborn related some results of a visit, with Dr. Matthews, to the Como Bluffs Section, south of the Union Pacific Railroad, three hours west of Laramie ; the more certain establishment of its Jurassic character, with bed containing remains of Dinosaurus about 40 feet below the top (a fresh water deposit), while, in the marine beds below, belemnites and btanodon were found, the latter serving as nuclei for concretions. Professor Osborn also described the mode of occurrence of the mastodon recently found by a German, while digging in his market garden, three miles back of Newburgh, N. Y.

Professor R. E. Dodge gave a preliminary account of his work on the Pueblo ruins at Pueblo Bamlo, New Mexico. The deposits on which the ruins are situated seem to indicate a a very long occupation of the country previous to the desertion of the ruins.

Dr. A. A. Julien discussed the common distribution of opal or hyalite ; and the exclusively recent character of all existing occurrences of this mineral.

Mr. Geo. F. Kunz described his recent visit to the ancient locality of jade (nephrite) at Jordaensmühl, near Breslau, Germany, with the special object of study of the minerals associated with jade. In an ancient quarry for road material, immense masses of zoisite-quartzite occurred, forming columns thirty feet in height.

Dr. Hovey presented some notes of an excursion with Professor Iddings to the Yellowstone Park.

Alexis A. Julien,
Secretary of Section.

THE CHEMICAL SOCIETY OF WASHINGTON.

The regular meeting was held October 12, 1899.

The first paper was read by Mr. J. K. Haywood and was entitled, 'The Determination of Glycogen,' by J. K. Haywood and W. D. Bigelow.

The authors proved that methods for the estimation of glycogen, which depend on its direct inversion into dextrose, are unreliable and have modified the method of Brücke so as to make it accurate and fairly rapid.

The second paper was read by Dr. F. K. Cameron and was entitled, 'A Method for Estimating Black Alkali in Soils.'

The method enables the determination of the degree of hydrolization of the sodium carbonate in soils and soil crusts containing this compound. It was shown that an accurate determination of the amount of sodium carbonate could not be made by titrating directly with a standard acid, two reactions taking place with the formation of the acid carbonate in varying quantities and furthermore the probable existence of acid carbonate in the soil adds to the difficulty of such a determination. It was shown that acid potassium sulfate is free from these objections, the reaction taking place with quantitative exactness according to this equation :

$$Na_2CO_3 + HKSO_4 = NaHCO_3 + NaKSO_4$$

both substances indicated in the right member of the equation being neutral. It should be borne in mind that acid sodium carbonate although a neutral substance towards indicators, quite rapidly and readily inverts with the formation of the alkaline normal carbonate, so that a reasonable degree of speed must be used in making the titration.

Details of the practical application of the method with examples from practice, were given, and it was shown that in ordinary practice the method was easily capable of an accuracy indicated by a probable error of less than 0.02 of 1 per cent.

The last paper was read by Dr. H. W. Wiley, and was entitled, 'The Fifteenth Annual Meeting of the Association of Official Agricultural Chemists, at San Francisco, July 5–7, 1899.'

Mr. Tassin exhibited a specimen of calcium chlorid which he had obtained from a muck soil found in Utah. The soil occurs as an incrustation between Salt Lake City and Salt Lake.

Dr. Bolton exhibited a bibliography of thallium compiled by Miss Martha Dunn and recently published by the Smithsonian Institution. He called attention to the work done in Paris by Jules Garcon, who has published a bibliography of the 'Chemical Technology of Textile Fibers,' and a pamphlet entitled, 'Resources of Bibliography of Chemistry.' The latter consists of a list of chemical bibliographies.

WILLIAM H. KRUG,
Secretary.

ONONDAGA ACADEMY OF SCIENCE.

THE September meeting was devoted to ornithology. Mr. J. A. Dakin spoke on the subject from an economical standpoint, and expressed the belief that the slaughter of birds for ornamentation is a chief factor in the destruction of farm crops by insects. Dr. W. M. Beauchamp considered forest denudation and changed food habits a more important factor.

Principal J. D. Wilson spoke on the study of birds from a naturalist's rather than a collector's standpoint, citing instances of familiarity between birds and their human friends and also his own experiences in taming young wild birds and studying their habits.

Mr. A. Perrior read a paper on 'The Oneida Lake Heronry.' In the tall trees of a submerged swamp at the north of Oneida Lake about five hundred pairs of Great Blue Herons (*Ardea herodias*) congregate annually at the breeding season. The nests are two or three feet in diameter and composed of half-inch sticks lined with finer twigs. Frequently two or three, and occasionally four, nests are built in the same tree, and are used indefinitely, being repaired from year to year. Mr. Perrior exhibited specimens of birds and eggs and also photographs taken among the tree tops.

At the October meeting Professor Hargitt spoke on the recent appearance in the county of the periodic *Cicada septendecim*, Riley's Brood No. XIX. The visitation lasted only about a month, was confined to parts of the towns of Onondaga and Dewitt and less damage was done than anticipated. The English sparrows were observed to feed greedily on the Cicadas, migrating in large numbers to the woods southeast of Syracuse. The brood is probably growing smaller in this county. Dr. Beauchamp confirmed the rumors of the Onondaga Indians feasting on the Cicadas and called attention to the restricted area of visitation, the Cicadas being confined to the central towns of the county.

Mr. H. W. Britcher spoke briefly on 'Protective Habits and Resemblances of Onondaga County Spiders,' and exhibited a number of live specimens illustrating the cases cited.

H. W. BRITCHER,
Corresponding Secretary.

DISCUSSION AND CORRESPONDENCE.

COLOR ASSOCIATIONS WITH NUMERALS, ETC.

TO THE EDITOR OF SCIENCE: In SCIENCE, Vol. VI. (1885), p. 242, I printed a note of experiments on color-associations with letters of the alphabet, days of the week, etc., in the case of my daughter Mildred. The subject was again treated, at more length, in *Nature* for July 9, 1891, p. 223. On p. 224 a table was given showing the color-associations for my daughter in 1882, 1883, 1885, 1887, 1889, 1891. Since that time I have tested her color-associations on two occasions. In February, 1895, her replies agreed exactly with the last column of the table cited except that the color for 8 was marked as 'white.' An experiment in August, 1899, agrees precisely with the results of 1895. I think the present note has a value because the experiments it describes now cover a period of seventeen years and give a history, not an isolated record.

EDWARD S. HOLDEN.

THE WAGNER FREE INSTITUTE OF SCIENCE AND PROFESSOR DALL.

ON Monday, October 30th, the Wagner Free Institute of Science in Philadelphia presented to Professor William Healey Dall, of the Smithsonian Institution, a gold medal as a slight token of their appreciation of his work in connection with the Transactions of the Institute. The medal has the head of the founder of the Institute on the obverse side, with the name of the Institution. On the reverse is engraved "Awarded to William Healey Dall for his investigations and writings in Paleontology—1899."

Accompanying the medal was a very handsomely engrossed book of resolutions stating that "Whereas, Professor William Healey Dall has contributed greatly to the advancement of Science by his investigations in the department of tertiary geology and has rendered most valuable service to the Wagner Free Institute of Science by enabling it, through his numerous and exhaustive contributions to its Transactions, to publish the results of his investigations to the world. Now, therefore, be it Resolved by the Board of Trustees and the Faculty of the Wagner Free Institute of Science that a medal be prepared and presented to Professor Dall in recognition of his distinguished services in the cause of Science and in testimony of the high appreciation of his work by the Trustees of this Institute."

The work on the Tertiary Fauna of Florida, begun in 1886 under the auspices of the Wagner Free Institute of Science, constitutes one of the most important advances in American Paleontology. The discovery of the Pliocene beds of the Caloosahatchie river by Professor Heilprin and Mr. Joseph Willcox in 1886 and the subsequent investigations by Dr. Wm. H. Dall have completely revolutionized the geological theory as to the formation of the Peninsula of Florida and the adjacent States.

The Transactions of the Institute have not only met with the highest commendation from American Paleontologists and Conchologists but from the European scientists as well. On several occasions prominent men from various parts of Europe have visited the Institute to see, as they said: "The Institution that has published such valuable and finely executed Transactions."

Some idea of the amount of labor involved in Dr. Dall's work may be gained from the following summary:

The total number of pages in the four parts of Vol. III. is 947, with 35 plates that contain 639 figures, and one map.

Part I. On the Gastropods. Contains references to over 300 species including the descriptions of 122 new species and varieties, that are represented on twelve plates by 192 figures.

Part II. Is a continuation of the Gastropods, as introductory chapter on the Marine Pliocene Bed of the Carolinas, and is followed by references to upwards of 400 species including the descriptions of 156 new species and varieties that are illustrated by 203 figures.

Part III. Forms an introductory chapter to Part IV. containing a new classification of the Pelecypoda, with an enumeration of the differential characters of the orders, suborders, superfamilies and families, a statement of their range in geological time, and an enumeration under each family of the chief generic groups believed to be referable to it.

In Part IV. Dr. Dall has greatly enlarged on the subject, giving a complete synopsis of many of the leading generic groups of American Tertiary species. Upwards of 500 species and varieties are enumerated, including 152 new to science. These are shown on 13 plates containing 244 figures.

The Pliocene fauna is closely allied to the recent, and Dr. Dall in his investigation has been obliged to make so many changes in nomenclature, that the work is indispensable to the paleontologist and conchologist.

In 1893 Professor Dall edited the republication of Conrad's 'Fossils of the Medial Tertiary of the United States' a work of 136 pages and 49 beautifully executed plates. In 1898 he wrote for the Transactions (Vol. 5), Notes on the Paleontological Publications of Professor William Wagner. Several plates prepared by Professor Wagner in 1839, but never published with text, were found in the Institute library. The plates were new species of fossils from the Carolinas for which credit was given in Brown's Index Paleontologicus, but there was no record of the original paper.

Professor Wagner doubtless had the plates prepared for the Journal of the Academy of Natural Sciences, and afterwards contented himself with sending the plates to his correspondents.

THOMAS L. MONTGOMERY.

PHILADELPHIA, Nov. 10, 1899.

THE CARNEGIE INSTITUTE.

THE fourth annual celebration of Founder's Day, of the Carnegie Institute at Pittsburg, was held on November 2d. President Arthur T. Hadley, who was the guest of honor, presented an address upon 'Modern Changes in Educational Ideals.'

Mr. Samuel H. Church, the secretary of the Board of Trustees, read the annual report of the progress of the year in all departments of the Institute, stating that a considerable plot of land had been secured to the east of the buildings for additions already planned, which are to provide space for a permanent picture gallery, an art school, and for the scientific museum.

The department of paleontology, recently established under the curatorship of Dr. Wortman, has progressed rapidly. The expedition to Wyoming this summer has resulted in the securing of a large collection of unusually fine fossil bones of extinct vertebrates.

Several addresses upon art were given, and the announcement was made of the prizes awarded for paintings entered in the Carnegie Institute exhibit for 1899.

Dr. J. L. Wortman then reported on the work of the museum in paleontology.

HARLAN I. SMITH.

*ALCOHOL AS FOOD.**

BULLETIN No. 69 of the Office of Experiment Stations of the U. S. Department of Agriculture gives the first detailed accounts of a number of experiments lately made by the Department in coöperation with Wesleyan University and the Storrs Experiment Station, under the immediate direction of Professor W. O. Atwater. These experiments were made with men in the Atwater-Rosa respiration calorimeter described in Bulletin No. 63 of the Office Experiment Stations. The object of the inquiries is the study of the laws of nutrition. Each experiment lasts from four to twelve days, during which time the man under experiment lives day and night in the chamber of the calorimeter. He has different kinds and amounts of food, and is under different conditions of activity, from actual rest to severe muscular or mental work. The results show how the body uses its food, what materials are needed for its support, and how different food materials compare in nutritive value. The six experiments reported in Bulletin No. 69 were made with a variety of dietaries and in two of them alcohol made a part of the diet.

The general plan of the experiments consists first in finding a diet of ordinary food materials, such as meat, potatoes, bread, and coffee, which is sufficient to meet the demands of the man's body when he is at rest, and in determining just how much of [the different materials must be added to meet the increased demands when the man is engaged in more or less severe muscular work. Arrangements are made by which all the food and drink supplied to the body, and

* From the Division of Publications, United States Department of Agriculture.

likewise all the excretory products given off from the body, are measured and analyzed. Even the air before and after it is breathed is thus treated. This gives the exact income and the outgo of matter of the body. Furthermore, the energy which is latent in the material supplied to the body, and in the excretory products given off from the body, is carefully determined; while the energy that is transformed by the body and given off in the form of heat and external muscular work is very accurately measured by the calorimeter. We thus have an exact measure of the income and outgo of energy. By thus striking the balance of income and outgo of both matter and energy, it is possible to learn with great accuracy just how the body utilizes the different materials supplied to it in food and drink.

When results had shown what quantities of food ingredients were required for the maintenance of the man's body when he was at rest, and how much more was necessary to enable him to perform a measured amount of muscular work, the experiments were repeated, but with this variation: A certain amount of the fuel ingredients of the food—sugar, starch and fat—which the body uses to furnish heat for warmth and energy for work, was taken out, and a chemically equivalent amount of alcohol was substituted for them; that is, an amount of alcohol which contained the same quantity of potential energy as the ingredients which it was to replace. As a matter of fact, the amount actually used was 2½ ounces of absolute alcohol per day—about as much as would be contained in three average glasses of whisky, or in a bottle of claret or Rhine wine. This alcohol was given in six nearly equal parts, three with meals and three between meals, the object being to avoid any especial influence of the alcohol upon the nerves, and thus to test its action as food under normal bodily conditions. In the experiments in which the man did no muscular work, this amount of alcohol furnished about one-fifth of the total energy of the food; but in those with hard muscular work more food was given, so that the alcohol supplied only about one-seventh of the energy.

As regards the special action of alcohol three important results were observed in these experiments: (1) Extremely little of the alcohol was given off from the body unconsumed, in the breath or otherwise. The alcohol was oxidized, *i. e.*, burned, as completely as bread, meat, and other ordinary foods, in the body and in the same way. (2) In the oxidation all of the potential energy of the alcohol burned was transformed into heat or muscular energy. In other words, the body transformed the energy of the alcohol just as it did that of sugar, starch and fat. (3) The alcohol protected the material of the body from consumption just as effectively as the corresponding amounts of sugar, starch and fat. That is, whether the body was at rest or at work, it held its own just as well when alcohol formed a part of the diet as it did with a diet without alcohol.

Besides the six experiments reported in Bulletin No. 69, the final result of thirteen later ones are ready for publication. Of these eight were with a diet including alcohol. In some of them pure alcohol was given, in others it was in the form of whisky or brandy. The two alcohol experiments in Bulletin No. 69, and ten of the later ones, were with the same subject, a Swede by birth who had lived some time in this country and had been accustomed from his youth to the use of small quantities of alcohol. For a time previous to the period of the experiments he abstained from all use of alcohol, and during that period he used only what was needed for the experiment. The subject of the other three experiments was a native American who had always been a total abstainer. The results of all these later experiments are practically the same as those described in Bulletin No. 69. No difference has been found with different forms of alcohol or with different subjects.

In unauthorized statements regarding these experiments, which have been widely disseminated, much more has been claimed for them than they legitimately cover. The fact is that these are purely scientific experiments of limited scope, in which small quantities of alcohol were consumed for brief periods of time. They do not show the effects of habitual or excessive use of alcohol as a beverage. Their purpose and nature are such that they give no evidence regarding its pathological or toxic action.

They simply show that the limited quantity of alcohol that was given with other food material in the diet of healthy men for periods of a few days was almost completely burned in the body and yielded a certain amount of energy, and that this energy was actually utilized by the body, as is the energy which the body obtains from sugar, starch, fat and other ingredients of food. The clear evidence of this fact presented by these experiments is an important contribution to our knowledge concerning the nutritive action of alcohol.

These experiments mark only a single step toward the settlement of the broad questions involved in the use of alcoholic beverages. It is believed that the facts presented by them are reliable. But it should be remembered that the physiological action of alcohol involves much beside its nutritive effect. Its influence upon the circulatory and nervous functions is especially important. These matters are not treated in Professor Atwater's experiments.

SCIENTIFIC NOTES AND NEWS.

DR. SAMUEL W. STRATTON, associate professor of physics in the University of Chicago, has been appointed director of the Bureau of Weights and Measures, United States Coast and Geodetic Survey.

THE Rumford Committee of the American Academy of Arts and Sciences has appropriated the sum of $500, to Professor E. B. Frost of the Yerkes Observatory, to assist in the construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight.

PROFESSOR H. A. ROWLAND of the John's Hopkins University has been elected a foreign member of the Royal Society of Lombardy.

AT the November meeting of the American Academy of Arts and Sciences, Mr. Rudyard Kipling was elected a foreign honorary member in Class III., Section 4; and Sir Benjamin Baker of London, a foreign honorary member in Class I., Section 4; the latter in the place of the late Sir Henry Bessemer.

OWING to the press of his official duties as the Hydrographer of the United States Geological Survey, Mr. F. H. Newell has been obliged to resign the Secretaryship of the National Geographic Society (Washington, D. C.), an office which he has ably and zealously filled for the last two years. As a successor to Mr. Newell the Society has been fortunate in securing the acceptance of the office by Mr. Joseph Stanley-Browne, well known as the editor of the publications and proceedings of the Geological Society of America.

THE National Academy of Sciences is holding its annual autumn meeting at Columbia University as we go to press.

THE American Society of Naturalists will meet at Yale University, New Haven, on Wednesday, December 28th. The discussion in the afternoon will be on 'The Position that Universities should take in Regard to Investigation.'

PRELIMINARY announcements have also been prepared in regard to the meetings at New Haven of the American Psychological Association and of the Anthropological Section of the American Association for the Advancement of Science. The meetings will be on Wednesday, Thursday and Friday, December 27th, 28th and 29th. In the case of the Psychological Association the address of the president, Professor Dewey, will be given on the afternoon of Wednesday, followed by an informal discussion, while on Thursday morning there will be simultaneous sectional meetings for technical papers.

THE New York Zoological Park was formally opened to the public on the 8th inst. An address of welcome was made by Professor Henry F. Osborn, Chairman of the Executive Committee of the Zoological Society, which was responded to by Mr. Bird S. Coler, Controller of the City, and Mr. August Moebus, Park Commissioner of the Borough of the Bronx. Mr. Levi P. Morton, President of the Zoological Society, then formally declared the Park open. Twenty-five buildings and other installations for animals have been completed, and these now contain 850 animals.

M. BÉNARD, the French architect whose plans for the University of California are described in the present issue of SCIENCE, will leave Paris this month for Berkeley.

A deputation representing the committee of the proposed university for Birmingham has come to America to study American universities. The deputation includes Professor J. H. Poynting whose address as president of the Physical Section of the British Association was recently published in this Journal.

Professor Battista Grassi has gone to Grosseto in order to complete his researches on the mosquitos concerned in the transmission of malarial infection.

The Allahabad *Pioneer Mail*, as quoted in *Nature*, states that Mr. Douglas Freshfield has started from Darjeeling, with a party of friends and Alpine guides, to explore the glaciers and little-known passes of the Kanchenjunga range of the Himalayas.

Miss Susie P. Nichols, B.S., Cornell University, '98, and Fellow in Botany at Cornell University, 1898–99, has been appointed holder of the Woman's Table at the Zoological Station at Naples for the autumn of 1899 and spring, 1900. She is engaged upon certain studies in the embryology of plants and has already entered upon her work at Naples.

The Medical Club of Philadelphia gave last week a reception to Professors Simon Flexner and John C. Clarke, who have this year severed their connection with the Johns Hopkins University to accept the chairs of pathology and gynecology at the University of Pennsylvania.

Nature states that copies in bronze of the medal presented to Sir G. G. Stokes at his jubilee can now be obtained from Messrs. Macmillan and Bowes, Cambridge, price fifteen shillings each.

The death is announced of Dr. A. Ernst, Director of the National Museum, Carácas, Venezuela.

Dr. Edward Petri professor of geography and anthropology, in the University of St. Petersburg, has died at the age of forty-five years.

Mr. Ottmar Mergenthaler, the inventor of the linotype machine, died at Baltimore on October 28th. The linotype substitute for type setting was first devised by him in 1880 and is now extensively used in newspaper offices.

The death is announced of Mr. James Simpson, curator of the anatomical museum of the University of Edinburgh. He did much towards devising methods of mounting and displaying museum specimens and was the author of papers on various scientific subjects.

Professor Andrew Gray, Lord Kelvin's successor at the University of Glasgow, chose as the subject of his inaugural address 'The Interaction of Theory and Practical Applications in Physical Science.'

At a special meeting of the Appalachian Mountain Club on November 22d, President T. C. Mendenhall, of Worcester Polytechnic Institute, will address the Club on the 'Controversy over Alaska.' President Mendenhall it will be remembered was one of the Commissioners on the Alaskan boundary.

The lecture courses offered by the National Geographic Society in Washington, of which a preliminary program has already been published in Science, have been successfully inaugurated. The Society is at present in a most flourishing condition, numbering some 1,200 active and 1,200 corresponding, or non-resident members.

The collection of birds secured by Professor Charles F. McClure and Mr. Sylvester, who were members of the recent Peary Relief Expedition, have been placed in the ornithological museum of Princeton University.

At the Detroit Art Museum there is now a special exhibition of 28 paintings and 38 sketches by Mr. Frank Wilbert Stokes, made while on the Peary Relief Expedition of 1892, and the North Greenland Expedition of 1893–94. Most of those of scientific interest are of geographical or geological subjects.

The Folk-Lore Society of Great Britain has offered to place on permanent deposit in the Museum of Archæology and Ethnology of Cambridge University the collection of objects illustrating the Folk-lore of Mexico, presented to the Society by Professor Starr of the University of Chicago, and the Antiquarian Committee has recommended that the offer be gratefully accepted. The collection consisting of upwards of 600 objects was made by Professor Starr in Mexico and was exhibited last June at a joint-

meeting of the Anthropological Institute and the Folk-Lore Society.

THE valuable library relating to American Indians collected by the eminent scholar, the late J. Hammond Trumbull, of Hartford, has been acquired by the Reference Library of Watkinson, Conn.

IT is stated in *Nature* that a British exploring expedition to Abyssinia has been arranged and will leave England at once. The members are Mr. James J. Harrison, Mr. Powell Cotton, Mr. W. Fitzhugh Whitehouse (of Newport, Rhode Island), and Mr. A. E. Butter. Mr. Donald Clarke will go as surveyor and geographer, and a taxidermist will accompany the party. The objects of the expedition are scientific and sporting, and it is expected that the journey will occupy about nine months.

THE first meeting of the new session of the Royal Geographical Society, was held on Monday, November 13th, when the President, Sir Clements Markham was expected to give a short opening address, to be followed by a paper by Mr. W. Rickmer Rickmers on his 'Travels in Bokhara,' illustrated by numerous lantern slides. The paper at the following meeting, November 27th, will be by Mr. Vaughan Cornish on 'Desert Sand Dunes.' At the December meeting Colonel Sir John Farquharson will probably give 'An Account of the Past Twelve Years' Work of the Ordinance Survey,' from the directorship of which he has recently retired. Other papers expected to be given during the session are: 'An Ascent of Mount Kenya,' by Mr. H. J. Mackinder; 'The Work of the Yermak Ice-Breaker in the Spitsbergen Seas,' by Admiral Makaroff; 'Travels in Central Asia,' by Captain H. H. P. Deasy; 'Travels in the Region of Lake Rudolf and the Sobat River,' by Captain Wellby; 'Travels in Abyssinia,' by Mr. H. Weld Blundell; 'Anthropogeography of British New Guinea,' by Professor Haddon.

THE Council of the Institution of Mechanical Engineers having decided to hold monthly general meetings during the ensuing session, the first of such gatherings took place on October 27th in the new buildings of the institution at Storey's-gate, St. James's Park. The London *Times* states that the chair was taken by the president, Sir W. H. White, and there was a full attendance of members. In opening the proceedings the president referred to the new arrangements made by the Council. He said that the alteration in their meetings had been decided upon only after the very fullest consideration. The feeling of the Council was that, having entered into their new house, they ought to make full use of it, and that a good beginning would be made by arranging monthly meetings during the winter. It has also been decided to hold their meetings on a single evening rather than, as had been the custom hitherto, on two three evenings in succession. By that means they hoped to get a better discussion. He could only appeal to the members to help in every way they could to make the new arrangement work successfully. They hoped to begin the graduates' meetings to-day. They looked to members to help them also in this new departure. A paper was then read by Mr. W. Ingham on 'The Incrustation of Pipes at the Torquay Waterworks.' He described the mechanical action of the scrapers constructed to remove the incrustation of the water pipes at Torquay, and the increase in the discharging power of the main affected by their use. Speaking generally he said it might be laid down with a fair approximation to the truth that well waters had not as great an action on pipes as those from upland gathering grounds, but where the water was soft the corrosive action would be greater. Filtered water had also a less corrosive power than unfiltered water. Much had been done to get a satisfactory coating to pipes, but there was still considerable room for improvement. It was hardly necessary to point out that a fortune awaited the man who could invent something that would withstand the action of soft waters. A discussion followed, and the meeting was adjourned until Friday, November 24th, when Lord Charles Beresford will read a paper on the opening for English engineers in China.

UNIVERSITY AND EDUCATIONAL NEWS.

As the result of a competition in which six invited forms of architects and three architectural firms in the city of St. Louis competed,

Messrs. Cope & Stewardson of Philadelphia were chosen as architects of the new buildings for Washington University. Mr. R. D. Andrews and Mr. R. Clipston Sturgis, of Boston, and Mr. Walter Cook, of New York, acted as advisers to the Board of Directors of the University in the competition. Messrs. Cope & Stewardson expect to have the plans for the new buildings completed by the first of March next; the work will then begin on the construction.

THE family of the late John Simkins, who was congressman from Massachusetts and a graduate of Harvard University, have given $20,000 to the Lawrence Scientific School of the University. The fund will be used to equip the mining and metallurgical laboratories and a bronze memorial tablet will be placed in one of the rooms.

THE will of the late Elizabeth Coles, leaving about $200,000 to found a Coles College in Newport, has been compromised, the City Council accepting $70,000 to endow a professorship of Natural Science in the Townsend Industrial School.

WE are glad to learn that the decree of the United States Circuit Court dismissing the bill of review in the Garcelon case has been affirmed. This should give Bowdoin College the property bequeathed to it valued at about $400,000.

THE chair of chemistry in the University of Toronto is vacant and will be filled as the result of applications addressed to the Minister of Education, Toronto, prior to January 1st, next. The salary is $2,500, rising by annual increments to $3,200. Further particulars may be obtained from the President of the University.

THE Council of St. John's College, Cambridge, has elected as fellows of the College, Mr. J. J. Lister, university demonstrator of animal morphology, and Mr. A. C. Seward, F.R.S., university lecturer in botany, known for his publications on paleobotany.

ALLEN S. WHITNEY has been appointed professor of the science and art of teaching in the University of Michigan.

PAUL I. MURRILL, B.S. (State College of Kentucky), Ph.D. (Michigan), of Detroit, has been appointed to the Stearns fellowship in pharmaceutical research at the University of Michigan.

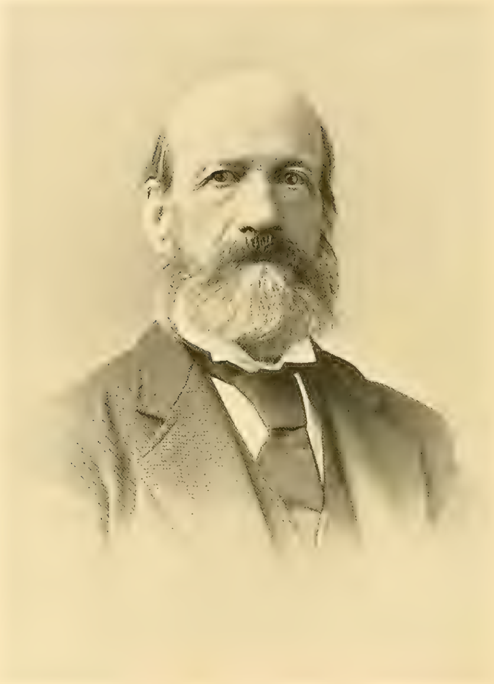
COLONEL J. W. OTTLEY, formerly Inspector-General of Irrigation in India, has been appointed president of the Royal Engineer's College, at Cooper's Hill, England.

DR. BERGER has been appointed professor of geography at Leipzig, and Professor M. v. Lenhossek, of Tubingen, has been called to the professorship of anatomy at Budapesth.

DR. W. FIGDOR has qualified as docent in plant anatomy and physiology at Vienna, and Dr. Pregl as docent in physiology at Gratz.

THE Ithaca correspondent of the New York *Evening Post* reports the appointment of non-resident lecturers in mechanical engineering at Cornell University as follows: November 3d, J. J. Swann, on 'Liquid Air'; November 17th, W. B. Snow, on 'Mechanical Ventilating and Heating'; December 1st, Professor Houston, on 'Evolution of Electric Energy'; December 15th, William Kent, on 'Power Production'; January 12th, H. E. Longwell, on 'New Westinghouse Gas Engine'; January 19th, A. E. Kennelly, on 'Electrical Engineering Experiences'; January 26th, C. J. Field, on 'Safe Current Transmission'; February 23d, W. P. Potter, on 'Three-Phase Railway Work'; March 9th, P. T. Dodge, on 'Mechanical Type-Setting'; April 13th, Elihu Thomson, on 'Special Work in Electrical Engineering'; April 27th, E. W. Rice, Jr., on 'Dynamo and Engine Construction'; May 4th, W. M. Macfarland, on 'Recent Engineering Practice.'

THE new University of London Hall for the Science of Political Economy, for which a site has been provided in the new street being formed by the London County Council in Clare-market, Strand, is to be proceeded with at once. The design by Mr. Maurice B. Adams, F.R.I.B.A., has been chosen by the trustees, of which body the Bishop of London and Mr. Sidney Webb, L.C.C., are active members. Mr. Passmore Edwards has given £10,000 towards the cost of the undertaking.



JOSEPH LOVERING.

SCIENCE

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FRIDAY, NOVEMBER 24, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REPORT ON THE NAVAL OBSERVATORY.

WE print on another page of our present issue the report of the Board of Visitors to the Naval Observatory, made on October 2d. Most astronomers will, we believe, agree with us that the work of the Board has been well done in several vital points. It is true that many details are left to be settled and much friction may be produced in putting the plan into operation. But, in any case, much will have been gained. The good features of the report are these:

We have for the first time what may be called an official admission that the Observatory must be reorganized on a civilian basis, made under such auspices and in such a way as to command attention. In stating the case all disagreeable details are avoided and, so far as possible, conclusions are intimated rather than expressed. Yet every point is so stated that no mistake of interpretation by the careful reader is possible. The optimistic impression always so agreeable to entertain, that, however weak may have been the administration from time to time in the past, it is now all right, is guarded against by stating that the scope of the remarks is not limited to the present time, but covers almost the

entire period of the existence of the Observatory. The hope is expressed that under an improved system the Observatory will attain and hold that high standing which should be expected of it, thus clearly intimating that this high standing does not belong to the past or present. What will happen if something effective is not done is stated very plainly. At the same time there is no reflection on any person or any authority.

The second feature of the proposed plan is the appointment of a Board of Visitors so organized as to secure efficiency. The great difficulty in the past has been that, although attempts have from time to time been made to improve the administration, there has been no authority to decide and report whether any real improvement had been effected. The proposed Board, containing as it does six astronomers of high professional standing, has to report at least annually on the efficiency with which the scientific work is prosecuted. If this work is in any way neglected, such a board will surely discover the reason and report what measures are necessary to insure success.

The third feature to which we refer guards against a result which has more than any other cause tended to weaken the efforts made in favor of reform. The fear has constantly been held forth that, in the event of a civilian organization being introduced, appointments would be made through political influence. This has been one of the favorite arguments against reform. The plan guards against this, by having the principal officers recommended to the appointing power by the Board of Visitors. One feature of the proceedings in making such nominations, shows a remarkably clear insight into the conditions of the case:

"The recommendations shall be determined only by a majority vote of the members present at a regularly called meeting of the Board in the city of Washington."

The great difficulty in the way of making the best nomination lies in the absence of discussion of the merits of the several candidates. We doubt not that, at such a meeting of the Board, the merits of every possible candidate would be discussed in the freest and fullest manner. In this way the best attainable result will be reached.

Minor defects in the report could be pointed out; but it might show a failure to appreciate the general excellence of the plan to consider these defects in detail. Two, however, may be mentioned. The powers of the proposed astronomical director are not defined. The question is thus left open whether the present system in which the director has all the responsibility for the astronomical work and no real power is to be continued.

Only one nomination to each office is provided for. This may be objected to as not leaving sufficient discretion to the appointing power. The French plan, on which two nominations to each office are made, the order of choice being indicated, seems to us preferable. The number might even be extended to three. As a general rule it might be expected that the appointing power would select the candidate pre-

ferred. At the same time circumstances might render the selection of the second advisable.

The unanimity of the report and the good feeling which has characterized the whole movement is one of the most encouraging features of the case. We trust that the plan will be enacted into law by Congress at its coming session.

REPORT OF THE BOARD OF VISITORS TO THE UNITED STATES NAVAL OBSERVATORY, OCTOBER 2, 1899.

WASHINGTON, D. C.,
October 2, 1899.

HON. JOHN D. LONG, *Secy. of the Navy.*

SIR: In compliance with the request contained in your letter of June 30, 1899, the undersigned have acted as a Board of Visitors to the United States Naval Observatory in Washington and now submit their report, including subdivisions as follows:

I. Recommendations of the Board of Visitors.

II. Circumstances leading to the appointment of the Board of Visitors.

III. Cost of the Observatory.

IV. Comparison with other Observatories.

V. Present condition and methods of observatory work and the delay in printing its results.

VI. Historical sketch of the Observatory.

VII. Minutes of the proceedings of the Board of Visitors.

VIII. Appendix.

The several portions of the report were put in form by the astronomers who are members of the Board. The recommendations are made unanimously.

Very respectfully,
WM. E. CHANDLER.
A. G. DAYTON,
EDWARD C. PICKERING.
GEO. C. COMSTOCK,
GEORGE E. HALE.

RECOMMENDATIONS OF THE BOARD OF VISITORS.

In accordance with the instructions contained in the following letter all the members of the Board of Visitors to the United States Naval Observatory therein named, met at the Observatory in Washington on Friday, June 30, 1899, and organized by the selection of William E. Chandler as Chairman, and George C. Comstock as Secretary.

NAVY DEPARTMENT,
Washington, June 30, 1899.

GENTLEMEN: In accordance with previous correspondence and oral conversations, you are hereby requested to act as a Board of Visitors at the United States Naval Observatory in Washington, convening there to-day, and to proceed to examine into the condition of that institution and to report to me your conclusions and recommendations.

Very respectfully,
JOHN D. LONG,
Secretary.

Hon. William E. Chandler,
Hon. Alston G. Dayton,
Professor Edward C. Pickering,
Professor George C. Comstock, and
Professor George E. Hale.

Captain Charles H. Davis, U. S. N., Superintendent of the Naval Observatory, presented to the Board an informal statement of circumstances leading to the appointment of the Board of Visitors and submitted correspondence relating thereto (Appendix, Exhibit A) and to a proposed reorganization of the Observatory (Appendix, Exhibit B). He also placed before the Board a list of professors of mathematics upon the active list of the navy (Appendix, Exhibit C) from which corps the staff of the observatory is largely drawn and a list of all persons performing duty at the observatory with their respective ranks (Appendix, Exhibit D).

At the request of Messrs. Chandler and Dayton there was submitted to the Board, by its other members, the correspondence conducted by them, as a Committee of the Second Annual Conference of Astronomers and Astrophysicists, for the purpose of obtain-

ing the views of American astronomers and physicists upon the organization and work of the Naval Observatory. Mr. Pickering submitted to the Board a statement regarding correspondence on the same subject conducted by a Committee of the American Association for the Advancement of Science.

In view of the facts brought before the Board at its several sessions and after the best consideration which it has been able to give to the subject, the Board of Visitors reports and recommends as follows:

The Naval Observatory, which was originally established as a scientific bureau, auxiliary to the needs of the naval service, has become through half a century of growth and through the expenditure of large sums of money, as authorized by law, an astronomical observatory of the first rank in respect of buildings, instruments and equipments. But by far the larger and more valuable part of its equipment has little or no reference to any direct requirement of the naval service and its existence can be justified only on the ground that Congress has intended to establish and maintain a national astronomical observatory. Under these changed circumstances its continued connection with the Navy Department has seemed to many of those whose views have been submitted to the Board of Visitors, illogical and undesirable. In view, however, of the absence of a national university, a Department of Science and Industries, or other department or bureau of the government especially suited to the conduct of such scientific work, and in view of the diversity of opinion among American astronomers upon the question to which existing department the observatory could be wisely transferred, we believe it to be inexpedient for us at the present time to further consider the subject of such transfer.

With reference to the organization of the Observatory under naval administration, the Board of Visitors disapproves of those parts of the 'Proposed Organization of Naval Observatory' (Appendix, Exhibit B), submitted under date of September 7, 1897, by 'F. E. Chadwick, Chief of Bureau of Equipment and C. H. Davis, Superintendent United States Naval Observatory,' which requires the establishment of a formal observatory council with nominal functions and which by omission practically abolish the office of Astronomical director. We are by no means objecting to the assembling in conference of the astronomers engaged in the observatory work, but the proposed transfer of duties and responsibilities from a single director to a committee of five appears to us a step in the wrong direction; and when, as under the proposed scheme, an absolute power of veto upon all action by the council is lodged in the hands of one of its members, the usefulness of the body seems to approach the vanishing point. In the history of observatories we have been unable to find a case of successful administration without a competent astronomer in immediate supervision of the work, and we believe that the ideal conditions for the successful administration of an astronomical observatory are most nearly realized when a professional astronomer is made the responsible director of the work. This system which is adopted in every great national observatory, the Board of Visitors believes to be the one best suited to secure the astronomical efficiency of the Naval Observatory.

If the naval observatory as a shore-station charged with the performance of certain functions assumed to have a relation to the navy is to continue under the command of a line officer, we recommend that the astronomical staff of the Naval Observatory shall consist of an Astronomical Director, four astronomers, three assistant astronomers and such computers and other minor officers as may be provided by law. The Astronomical Directors and astronomers, whether professors of mathematics

or taken from civil life, and the assistant astronomers, should be appointed by the President, by and with the advice and consent of the Senate, to hold their offices until their successors are appointed.

The Nautical Almanac office, which was formerly a distinct bureau, is now administered by departmental regulations as a part of the Naval Observatory, and it appears from the evidence submitted to the Board of Visitors that the successful administration of the Observatory is much impeded by reason of imposing upon its astronomical director, the duties of Director of the Nautical Almanac. Each of these offices furnishes abundant employment for the entire time of an able astronomer, and we therefore recommend that there shall be a Director of the Nautical Almanac appointed by the President, by and with the advice and consent of the Senate, to hold office until his successor is appointed.

We also recommend that provision be made for the continuation of the admirable series of memoirs published under the title 'Professional Papers of the American Ephemeris and Nautical Almanac.'

A criticism, frequently and forcibly urged against the administration of the Naval Observatory, not limited to the present time, but covering almost the entire period of its existence, is that its astronomical work has not been prosecuted with that vigor and continuity of purpose which should be shown in a national observatory. The possibility of conducting well planned researches with unvarying regularity over long series of years should constitute the great advantage of a national observatory, an advantage which is not fully realized in the history of the Naval Observatory, where each principal astronomer seems to have been left to choose his own line of work and to alter it from time to time or abandon it. This is perhaps inevitable in a system which places at the head of an observatory an officer who is not a technical expert in astronomical work; and therefore in order to secure continuity in the prosecution of work well chosen and coördinated with that of other observatories, and also to obtain for the observatory and the department advice and criticism which shall be both disinterested and responsible, we recommend the establishment of a permanent Board of Visitors substantially as follows:

There shall be appointed by the President, from persons not officers of the United States, a board of nine visitors to the Naval Observatory, six to be astronomers of high professional standing, and three to be eminent citizens of the United States. Appointments to this Board shall be made for periods of three years, but provision shall be made by initial appointments for shorter terms so that two astronomers and one member of the Board not an astronomer shall retire in each year. Members of this Board shall serve without compensation, but the Secretary of the Navy shall pay the actual expenses necessarily incurred by members of the Board in the discharge of such duties as are assigned them by the Secretary of the Navy, or are otherwise imposed upon them. The Board of Visitors shall make an annual visitation to the Naval Observatory at a date to be determined by the Secretary of the Navy and may make such other visitations, not exceeding two in number annually, by the full Board or by a duly appointed committee, as may be deemed needful or expedient by a majority of the Board.

The Board of Visitors shall report to the Secretary of the Navy at least once in each year the result of its examinations of the Naval Observatory as respects the condition of buildings, instruments and apparatus, and the efficiency with which its scientific work is prosecuted. The Board of Visitors shall prepare and submit to the Secretary of the Navy regulations prescribing the

scope of the astronomical and other researches of the Naval Observatory and the duties of its staff with reference thereto. When appointments or details are to be made to the office of Astronomical Director, Director of the Nautical Almanac, astronomer or assistant astronomer in the Naval Observatory, the Board of Visitors may recommend to the Secretary of the Navy suitable persons to fill such offices, but such recommendations shall be determined only by a majority vote of the members present at a regularly called meeting of the Board held in the city of Washington.

Special attention is at this point called to the fact that the appointment of a Board of Visitors to the Naval Observatory was recommended by Secretary Tracy in 1891, has been repeatedly urged by Superintendents of the Observatory, and is renewed by F. E. Chadwick, Chief of Bureau of Equipment, and C. H. Davis, Superintendent United States Naval Observatory, in the 'Proposed Organization of a Naval Observatory,' dated September 7, 1897 (Appendix, Exhibit B). The duties of the Board, as defined by these naval officers, would be in part as follows: "It lays down the general course of policy to be pursued for the coming year, including printing and publication of observations; fixes the estimates for the astronomical departments; nominates to fill vacancies in the astronomical staff (either by appointment or promotion); recommends as to repairs and acquisitions of new instruments.

If a permanent Board of Visitors as above recommended is established as a part of the administration of the Naval Observatory, it is evident that to it should be committed these questions of policy to be pursued in the conduct of the observatory which are contained in the memorandum (Appendix, Exhibit B), submitted to the present Board by the Secretary of the Navy, under date of June 28, 1899. We therefore abstain from specific recommendations upon these subjects, many of which indeed call for a more prolonged and minute study of the situation than the members of the present Board have been able to give to it.

We heartily endorse the recommendation contained in your report as Secretary of the Navy for the year 1897, that "the statute authorizing the appointment of professors of mathematics be so amended that without disturbing those who now hold office, which would be unjust to them, no further appointments shall be made" to the staff of Naval Observatory (Appendix, Exhibit L). In addition to the reasons for this action which are urged by you in that report, we submit for your consideration, that the conditions under which astronomical work is done are so different from those which obtain in the naval service, that a fixed tenure of office with the certainty of a retiring pension in no way dependent upon the zeal or efficiency with which service has been rendered, may easily produce diminished diligence and a purely perfunctory discharge of duties. A more serious evil of the existing system of naval commissions for astronomers, and one which has been forcibly exemplified within the past decade, is the compulsory retirement at the age of sixty-two of astronomers, who are then in the maturity of their powers, and who under civilian appointments would continue to render to the observatory a service of undiminished efficiency, which they now transfer to other institutions. The reasons which impel the retirement of a naval officer from active service upon attaining a fixed age have no application in the case of an astronomer, and he should be placed upon the same footing with other officers of the government performing strictly civilian duties.

If astronomers are appointed to the Naval Observatory from civil life to succeed retiring professors of mathematics, the salaries provided should be sufficient,

as recommended by you in that report for 1897, "to make up for the refusal to them of the privilege of retirement, and also to secure men of high scientific attainments adequate to the demands of one of the most capable observatories in the world." To secure the services of the ablest astronomers the salaries provided should be slightly larger than those paid in the higher class of university observatories and account should be taken of the fact that university vacations are much longer than leaves of absence from the public service. The Board of Visitors recommends the following as a schedule of salaries which could be expected to attract astronomers of the class desired :

Astronomical Director	$6000.
Director of Nautical Almanac	5000.
First Astronomer	4000.
Second "	3600.
Third "	3200.
Fourth "	2800.
First Assistant Astronomer	2400.
Second " "	2200.
Third " "	2000.

The experience of every great observatory shows that the efficiency of its staff is materially increased by the provision of quarters near the observing rooms for those persons who are engaged in work by night, and we recommend that there should be quarters provided upon the observatory grounds for all members of the astronomical staff regularly assigned to night work.

In concluding its recommendations, the Board of Visitors wishes earnestly to urge upon your consideration the necessity of making a success of the movement which you have begun, in order to improve the condition of the Naval Observatory, and to make its administration satisfactory to the great body of the astronomers of the country and to the public.

Some of our recommendations, if they meet your approval, can be carried into effect by departmental action, but the changes which we regard as vital can only be obtained through legislation by Congress. If such legislation is withheld, the continuance of present conditions is sure to result in a renewed, persistent, and possibly acrimonious demand for the removal of the observatory from naval control. If, however, the legislation is enacted, and the improved system is given a fair trial, unquestionably much improvement will result, and it is not improbable that the observatory will attain and hold that high standing in the scientific world which should be required of such an institution.

To help bring about such a desirable consummation, we have complied with your request, although not made in pursuance of any law, that we should visit and investigate the observatory, and we have recommended specific measures which we hope will lead to those reforms in administration which are imperatively necessary if the observatory is to receive and retain the confidence and support of the astronomers and scientists of the world.

ADDRESS OF THE PRESIDENT OF THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. *

I.

IN his opening address to the members of the British Association at the Ipswich meeting, the President cast a retrospective glance at the progress that had taken place in the several branches of scientific inquiry from the time of the formation of the Association in 1831 down to 1895, the year in which were published the last two of the fifty volumes of reports containing the scientific results of the voyage of H.M.S. *Challenger*. In that very able and detailed review there is no reference whatever to the work of the numerous expeditions which had been fitted out by this and other countries for the exploration of the depths

* Dover, 1899.

of the sea, nor is there any mention of the great advance in our knowledge of the ocean during the period of sixty-five years then under consideration. This omission may be accounted for by the fact that, at the time of the formation of the British Association, knowledge concerning the ocean was, literally speaking, superficial. The study of marine phenomena had hitherto been almost entirely limited to the surface and shallow waters of the ocean, to the survey of coasts and of oceanic routes directly useful for commercial purposes. Down to that time there had been no systematic attempts to ascertain the physical and biological conditions of those regions of the earth's surface covered by the deeper waters of the ocean ; indeed, most of the apparatus necessary for such investigations had not yet been invented.

The difficulties connected with the exploration of the greater depths of the sea arise principally from the fact that, in the majority of cases, the observations are necessarily indirect. At the surface of the ocean direct observation is possible, but our knowledge of the conditions prevailing in deep water, and of all that is there taking place, is almost wholly dependent on the correct working of instruments, the action of which at the critical moment is hidden from sight.

It was the desire to establish telegraphic communication between Europe and America that gave the first direct impulse to the scientific exploration of the great ocean-basins, and at the present day the survey of new cable routes still yields each year a large amount of accurate knowledge regarding the floor of the ocean. Immediately before the *Challenger* Expedition there was a marked improvement in all the apparatus used in marine investigations, and thus during the *Challenger* Expedition the great ocean-basins were for the first time systematically and successfully explored. This expedition, which lasted for nearly four years, was successful beyond the expectations of its promoters, and opened out a new era in the study of oceanography. A great many sciences were enriched by a grand accumulation of new facts. Large collections were sent and brought home, and were subsequently described by specialists belonging to almost every civilized nation. Since the *Challenger* Expedition there has been almost a revolution in the methods employed in deep-sea observations. The most profound abysses of the ocean are now being everywhere examined by sailors and scientific men with increasing precision, rapidity, and success.

The recognition of oceanography as a distinct branch of science may be said to date from the commencement of the *Challenger* investigations. The fuller knowledge we now possess about all oceanic phenomena has had a great modifying influence on many general conceptions as to the nature and extent of those changes which the crust of the earth is now undergoing and has undergone in past geological times. Our knowledge of the ocean is still very incomplete. So much has, however, already been acquired that the historian will, in all probability, point to the oceanographical discoveries during the past forty years as the most important addition to the natural knowledge of our planet since the great geographical voyages associated with the names of Columbus, Da Gama, and Magellan, at the end of the fifteenth and the beginning of the sixteenth centuries.

It is not my intention on this occasion to attempt anything like a general review of the present state of oceanographic science. But, as nearly all the samples of marine deposits collected during the past thirty years have passed through my hands, I shall endeavor briefly to point out what, in general, their detailed examination teaches with respect to the present condi-

tion of the floor of the ocean, and I will thereafter indicate what appears to me to be the bearing of some of these results on speculations as to the evolution of the existing surface features of our planet.

Depth of the Ocean.

All measurements of depth, by which we ascertain the relief of that part of the earth's crust covered by water, are referred to the sea-surface; the measurements of height on the land are likewise referred to sea-level. It is admitted that the ocean has a very complicated undulating surface, in consequence of the attraction which the heterogeneous and elevated portions of the lithosphere exercise on the liquid hydrosphere. In the opinion of geodesists the geoid may in some places depart from the figure of the spheroid by 1,000 feet. Still it is not likely that this surface of the geoid departs so widely from the mean ellipsoidal form as to introduce a great error into our estimates of the elevations and depressions on the surface of the lithosphere.

The soundings over the water-surface of the globe have accumulated at a rapid rate during the past fifty years. In the shallow water, where it is necessary to know the depth for purposes of navigation, the soundings may now be spoken of as innumerable; the 100-fathom line surrounding the land can therefore often be drawn in with much exactness. Compared with this shallow-water region, the soundings in deep water beyond the 100-fathom line are much less numerous; each year, however, there are large additions to our knowledge. Within the last decade over ten thousand deep soundings have been taken by British ships alone. The deep soundings are scattered over the different ocean-basins in varying proportions, being now most numerous in the North Atlantic and South-west Pacific, and in these two regions the contour-lines of depth may be drawn in with greater confidence than in the other divisions of the great ocean-basins. It may be pointed out that 659 soundings taken quite recently during cable surveys in the North Atlantic, although much closer together than is usually the case, and yielding much detailed information to cable engineers, have, from a general point of view, necessitated but little alteration in the contour-lines drawn on the *Challenger* bathymetrical maps published in 1895. Again, the recent soundings of the German s.s. *Valdivia* in the Atlantic, Indian, and Southern Oceans have not caused very great alteration in the positions of the contour-lines on the *Challenger* maps, if we except one occasion in the South Atlantic when a depth of 2,000 fathoms was expected and the sounding machine recorded a depth of only 536 fathoms, and again in the great Southern Ocean when depths exceeding 3,000 fathoms were obtained in a region where the contour-lines indicated between 1,000 and 2,000 fathoms. This latter discovery suggests that the great depth recorded by Ross to the southeast of South Georgia may not be very far from the truth.

I have redrawn the several contour-lines of depth in the great ocean-basins, after careful consideration of the most recent data, and these may now be regarded as a somewhat close approximation to the actual state of matters, with the possible exception of the great Southern and Antarctic Oceans, where there are relatively few soundings, but where the projected antarctic expeditions should soon be at work. On the whole, it may be said that the general tendency of recent soundings is to extend the area with depths greater than 1,000 fathoms, and to show that numerous volcanic cones rise from the general level of the floor of the ocean-basins up to various levels beneath the sea-surface.

The areas marked out by the contour-lines of depth are now estimated as follows:

Between the shore and 100 fms.,	7,000,000 sq. geo. m.	(or 7% of the sea-bed)
" 100 " 1,000 "	10,000,000 " "	(or 10% " ")
" 1,000 " 2,000 "	22,000,000 " "	(or 21% " ")
" 2,000 " 3,000 "	57,000,000 " "	(or 55% " ")
Over 3,000 fathoms,	7,000,000 " "	(or 7% " ")
	103,000,000 sq. geo. m.	100 per cent.

From these results it appears that considerably more than half of the sea-floor lies at a depth exceeding 2,000 fathoms, or over two geographical miles. It is interesting to note that the area within the 100-fathom line occupies 7,000,000 square geographical miles, whereas the area occupied by the next succeeding 900 fathoms (viz., between 100 and 1,000 fathoms) occupies only 10,000,000 square geographical miles. This points to a relatively rapid descent of the sea-floor along the continental slopes between 100 and 1,000 fathoms, and, therefore, confirms the results gained by actual soundings in this region, many of which indicate steep inclines or even perpendicular cliffs. Not only are the continental slopes the seat of many deposit-slips and seismic disturbances, but Mr. Benest has given good reasons for believing that underground rivers sometimes enter the sea at depths beyond 100 fathoms, and there bring about sudden changes in deep water. Again, the relatively large area covered by the continental shelf between the shore-line and 100 fathoms points to the wearing away of the land by current and wave action.

On the *Challenger* charts all areas where the depth exceeds 3,000 fathoms have been called 'Deeps,' and distinctive names have been conferred upon them. Forty-three such depressions are now known, and the positions of these are shown on the map here exhibited; twenty-four are situated in the Pacific Ocean, three in the Indian Ocean, fifteen in the Atlantic Ocean and one in the Southern and Antarctic Oceans. The area occupied by these thirty-nine deeps is estimated at 7,152,000 square geographical miles, or about 7 per cent. of the total water-surface of the globe. Within these deeps over 250 soundings have been recorded, of which twenty-four exceed 4,000 fathoms, including three exceeding 5,000 fathoms.

Depths exceeding 4,000 fathoms (or four geographical miles) have been recorded within eight of the deeps, viz., in the North Atlantic within the Nares Deep; in the Antarctic within the Ross Deep; in the Banda Sea within the Weber Deep; in the North Pacific within the Challenger, Tuscarora and Supau Deeps, and in the South Pacific within the Aldrich and Richards Deeps. Depths exceeding 5,000 fathoms have been hitherto recorded only within the Aldrich Deep of the South Pacific, to the east of the Kermadecs and Friendly Islands, where the greatest depth is 5,155 fathoms, or 530 feet more than five geographical miles, being about 2,000 feet more below the level of the sea than the summit of Mount Everest in the Himalayas is above it. The levels on the surface of the lithosphere thus oscillate between the limits of about ten geographical miles (more than eighteen kilometers).

Temperature of the Ocean-Floor.

Our knowledge of the temperature on the floor of the ocean is derived from observations in the layers of water immediately above the bottom by means of deep-sea thermometers, from the electric resistance of telegraph cables resting on the bed of the great ocean-basins, and from the temperature of large masses of mud and ooze brought up by the dredge from great

depths. These observations are now sufficiently numerous to permit of some general statements as to the distribution of temperature over the bottom of the great oceans.

All the temperatures recorded up to the present time in the sub-surface waters of the open ocean indicate that at a depth of about 100 fathoms seasonal variation of temperature disappears. Beyond that depth there is a constant, or nearly constant, temperature at any one place throughout the year. In some special positions, and under some peculiar conditions, a lateral shifting of large bodies of water takes place on the floor of the ocean at depths greater than 100 fathoms. This phenomenon has been well illustrated by Professor Libbey off the east coast of North America, where the Gulf Stream and Labrador Current run side by side in opposite directions. This lateral shifting cannot, however, be called seasonal, for it appears to be effected by violent storms or strong off-shore winds bringing up colder water from considerable depths to supply the place of the surface drift, so that the colder water covers stretches of the ocean's bed which under normal conditions are overlaid by warmer strata of water. Sudden changes of temperature like these cause the destruction of innumerable marine animals, and produce very marked peculiarities in the deposits over the areas thus affected.

It is estimated that 92 per cent. of the entire sea-floor has a temperature lower than 40° F.[1] This is in striking contrast to the temperature prevailing at the surface of the ocean, only 16 per cent. of which has a mean temperature under 40° F. The temperature over nearly the whole of the floor of the Indian Ocean in deep water is under 35° F. A similar temperature occurs over a large part of the South Atlantic and certain parts of the Pacific, but at the bottom of the North Atlantic basin and over a very large portion of the Pacific the temperature is higher than 35° F. In depths beyond 2,000 fathoms the average temperature over the floor of the North Atlantic is about 2° F. above the average temperature at the bottom of the Indian Ocean and South Atlantic, while the average temperature of the bed of the Pacific is intermediate between these.

It is admitted that the low temperature of the deep sea has been acquired at the surface in Polar and sub-Polar regions, chiefly within the higher latitudes of the southern hemisphere, where the cooled surface water sinks to the bottom and spreads slowly over the floor of the ocean into equatorial regions. These cold waters carry with them into the deep sea the gases of the atmosphere which are everywhere taken up at the surface according to the known laws of gas absorption. In this way myriads of living animals are enabled to carry on their existence at all depths in the open ocean. The nitrogen remains more or less constant at all times and places, but the proportion of oxygen is frequently much reduced in deep water, owing to the processes of oxidation and respiration which are there going on.

The deep sea is a region of darkness as well as of low temperature, for the direct rays of the sun are wholly absorbed in passing through the superficial layers of water. Plant-life is in consequence quite absent over 93 per cent. of the bottom of the ocean, or 66 per cent. of the whole surface of the lithosphere. The abundant deep-sea fauna, which covers the floor of the ocean, is, therefore, ultimately dependent for food upon organic matter assimilated by plants near its surface, in the shallower waters near the coast lines, and on the surface of the dry land itself.

As has been already stated, about 7,000,000 square geographical miles of the sea floor lies within the 100-fathom line, and

this area is in consequence subject to seasonal variations of temperature, to strong currents, to the effects of sunlight and presents a great variety of physical conditions. The planktonic plant life is here reinforced by the littoral seaweeds and animal life is very abundant. About 40 per cent. of the water over the bottom of this shallow water area has a mean temperature under 40° F., while 20 per cent. has a mean temperature between 40° and 60° F., and 40 per cent. a temperature of over 60° F.

It follows from this that only 3 per cent. of the floor of the ocean presents conditions of temperature favorable for the vigorous growth of corals and those other benthonic organisms which make up coral reefs and require a temperature of over 60° F. all year round. On the other hand, more than half of the surface of the ocean has a temperature which never falls below 60° F. at any time of the year. In these surface waters, with a high temperature, the shells of pelagic Molluscs, Foraminifera, Algæ, and other planktonic organisms are secreted in great abundance and fall to the bottom after death.

It thus happens that, at the present time, over nearly the whole floor of the ocean we have mingled in the deposits the remains of organisms which had lived under widely different physical conditions, since the remains of organisms which lived in tropical sunlight, and in water at a temperature above 80° F., all their lives, now lie buried on the same deposit on the sea-floor, together with the remains of other organisms which lived all their lives in darkness and at a temperature near to the freezing-point of fresh water.

Marine Deposits on the Ocean-floor.

The marine deposits now forming over the floor of the ocean present many interesting peculiarities according to their geographical and bathymetrical position. On the continental shelf, within the 100-fathom line, sands and gravel predominate, while on the continental slopes beyond the 100-fathom line, Blue Muds, Green Muds and Red Muds, together with Volcanic Muds and Coral Muds, prevail, the two latter kinds of deposits being, however, more characteristic of the shallow water around oceanic islands. The composition of all these Terrigenous Deposits depend on the structure of the adjoining land. Around continental shores, except where coral reefs, limestones and volcanic rocks are present, the material consists principally of fragments and minerals derived from the disintegration of the ancient rocks of the continents, the most characteristic and abundant mineral species being quartz. River detritus extends in many instances far from the land, while off high and bold coasts, where no large rivers enter the sea, pelagic conditions may be found in somewhat closer proximity to the shore line. It is in these latter positions that Green Muds containing much glauconite, and other deposits containing many phosphatic nodules, have for the most part been found; as, for instance, off the eastern coast of the United States, off the Cape of Good Hope, and off the eastern coasts of Australia and Japan. The presence of glauconitic grains and phosphatic nodules in the deposit at these places appears to be very intimately associated with a great annual range of temperature in the surface and shallow waters, and the consequent destruction of myriads of marine animals. As an example of this phenomenon may be mentioned the destruction of the tile-fish in the spring of 1882 off the eastern coast of North America, when a layer six feet in thickness of dead fish and other marine animals was believed to cover the ocean-floor for many square miles.

In all the Terrigenous Deposits the evidences of the mechanical action of tides, of currents, and of a great variety of physical

conditions, may almost everywhere be detected, and it is possible to recognize in these deposits an accumulation of materials analogous to many of the marine stratified rocks of the continents, such as sandstones, quartzites, shales, marls, greensands, chalks, limestones, conglomerates and volcanic grits.

With increasing depth and distance from the continents the deposits gradually lose their terrigenous character, the particles derived directly from the emerged land decrease in size and in number, the evidences of mechanical action disappear, and the deposits pass slowly into what have been called Pelagic Deposits at an average distance of about 200 miles from continental coastlines. The materials composing Pelagic Deposits are not directly derived from the disintegration of the continents and other land-surfaces. They are largely made up of the shells and skeletons of marine organisms secreted in the surface waters of the ocean, consisting either of carbonate of lime, such as pelagic Molluscs, pelagic Foraminifera, and pelagic Algæ, or of silica, such as Diatoms and Radiolarians. The inorganic constituents of the Pelagic Deposits are for the most part derived from the attrition of floating pumice, from the disintegration of water-logged pumice, from showers of volcanic ashes and from the *débris* ejected from submarine volcanoes, together with the products of their decomposition. Quartz particles which play so important a *rôle* in the Terrigenous Deposits, are almost wholly absent, except where the surface waters of the ocean are affected by floating ice, or where the prevailing winds have driven the desert sands far into the oceanic areas. Glauconite is likewise absent from these abysmal regions. The various kinds of Pelagic Deposits are named according to their characteristic constituents, Pteropod Oozes, Globigerina Oozes, Diatom Oozes, Radiolarian Oozes and Red Clay.

The distribution of the deep-sea deposits over the floor of the ocean is shown on the map here exhibited, but it must be remembered that there is no sharp line of demarcation between them ; the Terrigenous pass gradually into the Pelagic Deposits, and the varieties of each of these great divisions also pass insensibly the one into the other, so that it is often difficult to fix the name of a given sample.

On another map here exhibited the percentage distribution of carbonate of lime in the deposits over the floor of the ocean has been represented, the results being founded on an extremely large number of analyses. The results are also shown in the following table :

	Sq. Geog. Miles.	Percentage.
Over 75% $CaCO_3$......	6,000,000	5·8
50 to 75% "	24,000,000	23·2
25 to 50% "	14,000,000	13·5
Under 25% "	59,000,000	57·5
	103,000,000	100

The carbonate of lime shells derived from the surface play a great and puzzling *rôle* in all deep-sea deposits, varying in abundance according to the depth of the ocean and the temperature of the surface waters. In tropical regions removed from land, where the depths are less than 600 fathoms, the carbonate of lime due to the remains of these organisms from the surface may rise to 80 or 90 per cent.; with increase of depth, and under the same surface conditions, the percentage of carbonate of lime slowly diminishes, till, at depths of about 2,000 fathoms, the average percentage falls to about 60, at 2,400 fathoms to about 30, and at about 2,600 fathoms to about 10, beyond which depth there may be only traces of carbonate of lime due to the presence of surface shells. The thin and more delicate surface shells first disappear from the deposits ; the thicker and denser ones alone persist to greater depths. A careful examination of a large number of observations

shows that the percentage of carbonate of lime in the deposits falls off much more rapidly at depths between 2,200 and 2,500 fathoms than at other depths.

The Red Clay which occurs in all the deeper stretches of the ocean far from land, and covers nearly half of the whole sea-floor, contains—in addition to volcanic *débris*, clayey matter, the oxides of iron and manganese—numerous remains of whales, sharks, and other fishes, together with zeolytic crystals, manganese nodules, and minute magnetic spherules, which are believed to have a cosmic origin. One haul of a small trawl in the Central Pacific brought to the surface on one occasion, from a depth of about two and a half miles, many bushels of manganese nodules, along with fifteen hundred sharks' teeth, over fifty fragments of earbones and other bones of whales. Some of these organic remains, such as the *Carcharodon* and *Lamna* teeth and the bones of the Ziphioid whales, belong apparently to extinct species. One or two of these sharks' teeth, earbones or cosmic spherules, may be occasionally found in a Globigerina Ooze, but their occurrence in this or any deposits other than Red Clay is extremely rare.

Our knowledge of the marine deposits is limited to the superficial layers; as a rule the sounding tube does not penetrate more than six or eight inches, but in some positions the sounding-tube and dredge have been known to sink fully two feet into the deposit. Sometimes a red clay is overlaid by a Globigerina Ooze, more frequently a Red Clay overlies a Globigerina Ooze, the transition between the two layers being either abrupt or gradual. In some positions it is possible to account for these layers by referring them to changes in the condition of the surface waters; but in other situations it seems necessary to call in elevations and subsidences of the sea-floor.

If the whole of the carbonate of lime shells be removed by dilute acid from a typical sample of Globigerina Ooze, the inorganic residue left behind is quite similar in composition to a typical Red Clay. This suggests that possibly, owing to some hypogene action, such as the escape of carbonic acid through the sea-floor, a deposit that once was a Globigerina Ooze might be slowly converted into a Red Clay. However, this is not the interpretation which commends itself after an examination of all the data at present available; a consideration of the rate of accumulation probably affords a more correct interpretation. It appears certain that the Terrigenous Deposits accumulate much more rapidly than the Pelagic Deposits. Among the Pelagic Deposits the Pterapod and Globigerina Oozes of the tropical regions, being made up of the calcareous shells of a much larger number of tropical species, apparently accumulate at a greater rate than the Globigerina Oozes in extra-tropical areas. Diatom Ooze being composed of both calcareous and siliceous organisms has again a more rapid rate of deposition than Radiolarian Ooze. In Red Clay the minimum rate of accumulation takes place. The number of sharks' teeth, of earbones and other bones of Cetaceans, and of cosmic spherules in a deposit may indeed be taken as a measure of the rate of deposition. These spherules, teeth and bones are probably more abundant in the Red Clays, because few other substances there fall to the bottom to cover them up, and they thus form an appreciable part of the whole deposit. The volcanic materials in a Red Clay having, because of the slow accumulation, been for a long time exposed to the action of the sea-water, have been profoundly altered. The massive manganese-iron nodules and zeolitic crystals present in the deposit are secondary products arising from the decomposition of these volcanic materials, just as the formation of glauconite, phosphatic, and calcareous and barytic nodules accompanies the decompo-

sition of terrigenous rocks and minerals in deposits nearer continental shores. There is thus a striking difference between the average chemical and mineralogical composition of Terrigenous and Pelagic Deposits.

It would be extremely interesting to have a detailed examination of one of those deep holes where a typical Red Clay is present, and even to bore some depth into such a deposit if possible, for in these positions it is probable that not more than a few feet of deposit have accumulated since the close of the Tertiary period. One such area lies to the south-west of Australia, and its examination might possibly form part of the program of the approaching antarctic explorations.

Life on the Ocean-floor.

It has already been stated that plant-life is limited to the shallow waters, but fishes and members of all the invertebrate groups are distributed over the floor of the ocean at all depths. The majority of these deep-sea animals live by eating the mud, clay, or ooze, or by catching the minute particles of organic matter which fall from the surface. It is probably not far from the truth to say that three-fourths of the deposits now covering the floor of the ocean have passed through the alimentary canals of marine animals. These mud-eating species, many of which are of gigantic size when compared with their allies living in the shallow coastal waters, become in turn the prey of numerous rapacious animals armed with peculiar prehensile and tactile organs. Some fishes are blind, while others have very large eyes. Phosphorescent light plays a most important *rôle* in the deep sea, and is correlated with the prevailing red and brown colors of deep-sea organisms. Phosphorescent organs appear sometimes to act as a bull's-eye lantern to enable particles of food to be picked up, and at other times as a lure or a warning. All these peculiar adaptations indicate that the struggle for life may not be much less severe in the deep sea than in the shallower waters of the ocean.

Many deep-sea animals present archaic characters; still the deep sea cannot be said to contain more remnants of faunas which flourished in remote geological periods than the shallow and fresh waters of the continents. Indeed, king-crabs, Lingulas, Trigonias, Port Jackson sharks, *Ceratodus*, *Lepidosiren* and *Protopterus* probably represent older faunas than anything to be found in the deep sea.

Sir Wyville Thompson was of the opinion that, from the Silurian period to the present day, there had been as now a continuous deep ocean with a bottom temperature oscillating about the freezing-point of fresh water, and that there had always been an abyssal fauna. I incline to the view that in Paleozoic times the ocean-basins were not so deep as they are now; that the ocean then had throughout a nearly uniform high temperature, and that life was either absent or represented only by bacteria and other low forms in great depths, as is now the case in the Black Sea, where life is practically absent beyond 100 fathoms, and where the deeper waters are saturated with sulphuretted hydrogen. This is not, however, the place to enter on speculations concerning the origin of the deep-sea fauna, nor to dwell on what has been called 'bipolarity' in the distribution of marine organisms.

JOHN MURRAY.

(*To be Continued.*)

THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.

IV.

LOVERING.*

Lovering † was born in Charlestown, Massachusetts, now a portion of Boston, in

* A portrait of Joseph Lovering is printed as frontispiece.

† See sketch in *Popular Science Monthly*, with an engraved portrait on wood, Vol. XXXV., p. 690, September, 1889. Also see article in *Scientific American*, February 27, 1892, with a half-tone portrait.

1813, and inherited a fondness for mathematics from his father who was a surveyor by profession. He was fitted for college by the Rev. James Walker, and entered Harvard in the Sophomore year in the class of 1833, a class that included several members who were afterwards called to fill chairs in their *alma mater,* and one—Jeffries Wyman—who became a president of our Association. Lovering stood fourth in his class and he delivered the salutatory oration at the commencement exercises.

For a year after leaving Harvard he taught in Charlestown, but an inclination towards theology led him to enter the Harvard Divinity School, also at the same time devoting some attention to mathematical studies. It was probably that fact that led to his appointment as tutor in mathematics and physics in 1836 to fill the place made vacant by the illness of Professor John Farrar, and thus his long connection with Harvard began which only terminated in his death, fifty-six years later.

In 1838 Professor Farrar retired from active duty and Lovering was made his successor in the Hollis chair of mathematics and natural philosophy, which he then held for exactly fifty years, when he in his turn retired and was made *emeritus.* He was the first member of the Harvard faculty to fill a professorship for half a century, and his length of academic service was only exceeded by that of Henry Flynt, who was a tutor in Harvard, early in its history. Lovering was also director of the Jefferson Physical Laboratory, holding that office during 1884–88, and he was a regent of Harvard during 1853–54 and again during 1857–70.

In the development of the Harvard astronomical observatory he took a prominent part. He was associated with Professor William C. Bond in 1840, when with but few instruments and indifferent facilities, the beginning of the work in astronomy was made in the Davis House in Cambridge. It is from this small beginning that the present splendid observatory has grown. When Alexander von Humboldt induced the Royal Society of London to undertake the procuring of simultaneous observations on terrestrial magnetism in Great Britain and the colonies, the coöperation of the United States was sought, and one of the three stations in America was located in Cambridge where the taking of the observations was under the direction of Bond and Lovering. Several undergraduates of Harvard aided in the work, and among them was Benjamin A. Gould, who served the American Association as president in 1868.

The exacting duties of his work at Harvard and his own active interest in our Association left him but little time for scientific investigations. Still from 1867 till 1876 he had charge of the computations for determining transatlantic longitudes from telegraphic observations on cable lines, and under the direction of the U. S. Coast Survey, of which his colleague Benjamin Peirce was then superintendent, and the results of his work were given in volumes II. and IX. of the memoirs of the American Academy of Arts and Sciences. It was also to this source that he contributed in 1873 his great memoir on the aurora borealis. His shorter papers were more than one hundred in number and many of them appeared in our Proceedings. They testify to his unceasing activity as well as to his unusual ability. Mention should be made also of the fact that he was associated with Benjamin Peirce in the publication of the Cambridge Miscellany of Mathematics and Physics, to which he contributed articles on The Internal Equilibrium of Bodies; The Application of Mathematical Analysis to Physical Research; The Divisability of Matter, and similar subjects which attracted wide attention throughout this country and the scientific world.

It would be pleasant to review at length his work in connection with the American Association, but the memory of fifteen successful meetings and an equal number of volumes of Proceedings edited by him are all that need be mentioned. His interest in the American Academy of Arts and Sciences was also noteworthy. He was its secretary during 1869–73; its vice-president during 1874–80, and its president during 1881–88.

And so it was with the American Association, the magnificent pioneer work by Lovering made possible the wonderful successes by Putnam, during whose administration our Association reached its high tide of membership and attendance. We shall do well to place the name of Lovering high among those of the fathers of the Association.

The successful meeting in Portland was followed by the even more successful meeting at Hartford, Connecticut, which, according to the permanent secretary, "was one that will make a special era in the history of the Association."* In attendance it was one of the three largest meetings held, subsequent to their resumption in 1866. The presiding officer of the meeting was John Lawrence Le Conte, of Philadelphia.

LE CONTE.

This distinguished entomologist† was born in New York City in 1825. He was of Huguenot ancestry, as is suggested by his name. The first of the family to come to this country was Guillaume Le Conte, who settled in New Rochelle early in the eighteenth century. Among his descendants were Lewis and John Eatton Le Conte, both of whom achieved some prominence for their interest in science. The latter, Major John Eatton Le Conte, entered the U. S. Topographical Engineers and was distinguished as a botanist and as an entomologist. His son is the subject of this sketch.

* Proceedings, American Association for the Advancement of Science, Vol. XXIII., p. 150.

† Biographical Memoirs of the National Academy of Sciences, Vol. XI., p. 216. John Lawrence Le Conte, by Samuel H. Scudder. This article, accompanied by a photo-gelatine portrait, appeared in the *Transactions of the American Entomological Society* for August, 1884. The *Popular Science Monthly*, Vol. V., p. 620, September, 1874, contains a sketch with engraved portrait on wood.

After finishing his collegiate education at Mount St. Mary's College, in Emmettsburg, Maryland, Le Conte entered the College of Physicians and Surgeons in New York City and was graduated there in 1846. Possessed of independent means, he never took up the actual practice of medicine, but yielded to a fondness for natural history, inherited from his father, he devoted himself to travel, visiting many portions of the United States during the years between 1841 and 1851.

Says Scudder:

> The subject of the faunal relations of animals was a favorite one with Le Conte. He returned to it again and again; he was the first to district much of the vast and then almost unexplored regions west of our prairie country.*

While still a student of medicine he published his first scientific paper, which contained descriptions of more than twenty species of Caribidæ from the eastern United States. His preference for entomology continued throughout his life, and how industrious he was in that direction and what an influence he exerted on that branch of science, is shown by the statement that more than sixty monographic essays, some of them expanding to the form of a volume, and all of them after the first five years of work, direct and valuable contributions to the taxonomy of the order (Coleoptera) appeared from his pen.†

The sketch by Scudder, from which so

* Biographical Memoirs, p. 272.

† Samuel H. Scudder, in Biographical Memoirs, p. 274.

much of this material has been taken, contains the following appreciation of Le Conte's work:

That Le Conte was the greatest entomologist this country has yet produced is unquestionable. *Facile princips* will be the universal judgment both now and by posterity.*

Mention must be made of the fact that when the civil war broke out he entered the Union army as surgeon of volunteers and was afterward advanced to the office of medical inspector, with the rank of lieutenant colonel, which he retained until the end of the war. In this duty his fine organizing power and good sense showed themselves to excellent advantage. From 1878 till his death in 1883, he again served the government as chief clerk of the U. S. Mint in Philadelphia.

One of our past presidents, Lesley, who was his life-long friend, said of him:

Let the world reverence his memory as a discoverer, as a philosopher, as a genius.

HILGARD.

For the meeting held in Detroit in 1875 Julius Erasmus Hilgard, of the U. S. Coast Survey, was chosen to preside, and thus for a third time in our history an officer of the U. S. Coast Survey was honored by an election to the highest office within the gift of our Association. Hilgard† was the eldest son of a distinguished Bavarian jurist and writer and came with his father to this country in 1835. Although at that time only ten years of age, he had completed the third grade of the gymnasium in his native town of Zweibrucken, and his subsequent education was for the most part obtained from his father or self-acquired.

* Samuel H. Scudder, in Biographical Memoirs, p. 280.

† Biographical Memoirs of the National Academy Vol. III., p. 327. Julius E. Hilgard, by Eugene W. Hilgard. See also sketch with engraved portrait on wood in *Popular Science Monthly*, Vol. VII., p. 617, September, 1875, and Appleton's Annual Cyclopædia for 1891, p. 628, with portrait.

In 1843 he went to Philadelphia with a view to the study of engineering and practical employment. He was soon actively at work on one of the new railway lines then coming into existence. While so engaged he became acquainted with Alexander D. Bache, and in 1845 when Bache became superintendent of the Coast Survey, he offered young Hilgard a subordinate appointment in this service, which was promptly accepted with the statement that he preferred to "do high work at low pay than low work at high pay."*

In the short time of fifteen years he rose from the lowest place in the survey to that of first assistant, which was second only to the office of superintendent. During the greater part of the civil war and until the death of Bache in 1867, the actual duties of the superintendent devolved on him. Peirce, who succeeded Bache said of this service:

The distinguished ability with which this difficult service was discharged was manifest to all. He (Hilgard) has extended to me the benefit of this experience liberally and loyally. While I willingly acknowledge myself under deep and lasting obligations to him for the aid thus rendered me, I can also testify that in all respects he has been equally true to my predecessor, the greatness of whose reputation has not been diminished in his keeping.

Hilgard continued as assistant in charge of the office during the superintendency of Peirce, and his successor, Patterson, but in 1881 his services received their just reward by his appointment as superintendent of the Coast Survey, which place he then held for four years. On the advent of a new administration, after a faithful service of forty years, he was obliged to resign. It is not pertinent to this address to discuss the reasons that led to his resignation, but

There can be no two opinions upon the character and value of his life-work in connection with the Coast Survey. He brought into

*Biographical Memoirs, p. 330.

that branch of the public service a rare combination of culture, zeal, knowledge of the world, and executive ability; and no man living will claim to have done more than he did for the character and efficiency of the survey.*

The arduous and confining duties of his office in the Coast Survey naturally limited his scientific work to the sphere embraced by his practical work, but he was also recognized "as an active student in other branches of science, especially dynamics and molecular physics."† Of such work, the most important, however, was that connected with the magnetic survey of the United States, which was carried on at the expense of the Bache fund, the direction of which was entrusted to Hilgard by the National Academy of Sciences.

His lectures on The Tides and Tidal Action in Harbors, delivered before the American Institute in New York, was regarded as remarkable for its lucid and terse exposition of principles without the aid of mathematical symbols. Later he delivered a course of twenty lectures before the students of the Johns Hopkins University on the subject of Extended Territorial Surveying, which was received with much appreciation.

His life-work, however, was in connection with the Coast Survey, and his relation to it will always be accepted as his greatest contribution to American science. From 1886 till his death, in 1891, he lived quietly in retirement, vainly endeavoring to regain the health and strength which he had sacrificed in the patriotic performance of his duty to the country of his adoption.

ROGERS.

It was indeed a happy suggestion that led our Association in 1881 to recognize the lifelong interest of William Barton Rogers in its welfare by electing him as the first of our

* SCIENCE, May 15, 1891.

† *Popular Science Monthly*, Vol. VII., p. 618.

honorary fellows. Rogers was the last presiding officer of the Association of American Geologists and Naturalists, and it was he who inducted to office William C Redfield, at the first meeting of the American Association in 1848. It is for this reason that his name stands first in the list of our presidents. This name also appears as the twenty-fifth on the list, for in 1875 he was honored by an election to the presidency and he presided over the meeting held in Buffalo in 1876.

It is not an easy matter to find a suitable designation for so versatile and accomplished a scientist as Rogers, for he was master of more subjects than one, and belonged to a period in the history of science, when teachers were students and authorities in several branches of learning. He was one of the four sons of Patrick K. Rogers, who, for a decade, was professor of natural philosophy and mathematics at William and Mary College, Virginia. William Barton* was born in Philadelphia in 1804, and followed his parents to Williamsburg, in 1819. His early education was received from his father, and for a time he was a student of William and Mary. Later he became an assistant to his father, who wrote:

My second son, who is now in his twentieth

* There are many sketches of W. B. Rogers, among which are a notice of William Barton Rogers, founder of the Massachusetts Institute of Technology, by Josiah P. Cooke, in *Proceedings of the American Academy of Arts and Sciences*, Vol. XVIII., p. 426; Memoirs of William Barton Rogers, 1804–1882, presented before the National Academy, by Francis A. Walker; The Brothers Rogers read before the American Philosophical Society, by Dr. William S. W. Ruschenberger; and a memorial pamphlet issued by the Massachusetts Institute of Technology with a photo-gelatine portrait. There is also a sketch in the *Popular Science Monthly*, Vol. IX., p. 606, September, 1876, with an engraved portrait on wood, where monthly there has been published a life and letters of William Barton Rogers edited by his wife, Emma Savage Rogers, in two volumes, Boston, 1896, that contains several portraits both of himself and of his brothers.

year, and has a very extraordinary passion for physico-mathematical sciences.*

In the autumn of 1825, with his younger brother, Henry, he went to Baltimore, and there, for a time, pursued various vocations including that of scientific advisor to Isaac Tyson, the chemical manufacturer, but chiefly that of teacher in a school established by the two young men in Windsor. The pursuit of science was the aim of his ambition, and he was fortunate in securing an appointment, early in 1827, to deliver a course of lectures before the Maryland Institute. These were so successful that he gave a second course a year later. Concerning these Henry wrote to his father:

William is still able to command large and ever increasing classes. * * * I cannot refrain from expressing my surprise at William's great success, aided as he is by little more than the blackboard and chalk.†

Walker said of these lectures that he then:

First displayed upon an adequate field, that power of clear exposition felicitous illustration which he possessed in a degree, perhaps, never excelled.‡

In August, 1828, came the death of the elder Rogers, and two months later William was chosen his father's successor in the chair of natural philosophy and chemistry in William and Mary College, "and thence forward became, in a large measure, the head of the family."§ For some years he continued in the active possession of that chair, also during part of the time temporarily filling the chair of mathematics. His professorial duties were naturally paramount, but it must be noted that at that time he published a paper on Dew, and with his brother Henry one on the Voltaic Battery, both of which were subjects directly connected with his professorship.

* Life and Letters, p. 26.

† Idem, p. 47.

‡ Biographical Memoirs, p. 3.

§ Life and Letters, p. 54.

Of subjects less directly associated with his college duties, to which he devoted much attention, were topics connected with geology. He wrote a series of articles on the Green Lands and Marls of Eastern Virginia, describing their value as fertilizers, and says Cooke:

Next we find the young professor going before the legislature of Virginia, and, while modestly presenting his own discoveries, making them the occasion for urging upon that body the importance of a systematic geological survey for developing the resources of the State.

The year 1835 saw the culmination of his ambition in that respect, for in March he was appointed director of the Geological Survey of Virginia.

As was anticipated, says Cooke:

The survey led to a large accumulation of material, and to numerous discoveries of great local importance. As this was one of the earliest geological surveys undertaken in the United States, its directors had, in great measure, to devise the methods and lay out the plans of investigation which have since become general. * * * [Also] there are four or five general results of Professor Roger's geological work at this period, which have exerted a permanent influence in geological science.*

These general results included the study of the solvent action of water in various minerals and rocks; the demonstration that coal beds stand in close genetic relation to the amount of disturbance to which the inclosing strata have been submitted; the announcement and discussion of the wave theory of mountain chains; and the law of distribution of faults. In working out these subjects and in the presentation of papers discussing them he was associated largely with his brother Henry, who was at that time State Geologist of Pennsylvania. It has been well said that "together they unfolded the historical geology of the great Appalachian chain."

* Notice of William Barton Rogers, p. 429.

Popular interest in the survey gradually dwindled, and in the legislature decided opposition manifested itself, until in 1841, its political enemies succeeded in preventing the passing of an appropriation and so the survey came to an end.

It was also in the year 1835 that Rogers was chosen to the chair of natural philosophy and geology in the University of Virginia. Of his career, then President William L. Brown, of the Agricultural and Mechanical College of Alabama is quoted as saying:

I have seen his lecture hall so crowded with young men, eager to hear his eloquent presentation of the subject by the professor, whom they so greatly admired, that not even standing room could be found in the hall. All the aisles would be filled, and even the windows crowded from the outside with eager listeners. His manner of presenting the commonest subject in science—clothing his thoughts, as he always did, with a marvelous fluency and clearness of expression and beauty of diction unsurpassed—caused the warmest admiration, and often aroused the excitable nature of Southern spirit to the exhibition of enthusiastic demonstrations of approbation.

He resigned his chair in 1853 in order to devote more of his time to original investigation, but the students never forgot him, and at the celebration of the semi-centennial of the University of Virginia in 1875, he received a perfect ovation. In the language of a contemporary Virginia newspaper:

The old students beheld him the same William B. Rogers who thirty-five years before had held them spellbound in his class of natural philosophy; and as the great orator warmed up, then men forgot their age; they were again young; and showed their enthusiasm as wildly as when in days of yore enraptured by his eloquence, they made the lecture room of the university ring with their applause.*

Ever since boyhood it had been his cherished hope to work some day side by side with his brother Henry. Such an opportunity now presented itself. The younger man had settled in Boston some years previous, and released from the duties of his collegiate work, William B. Rogers, gladly sought the congenial atmosphere of the northern city where it was possible to devote himself to original work. He associated himself with the American Academy of Arts and Sciences and the Boston Society of Natural History, taking an active part in the proceedings of both of these learned societies, in the latter of which he was in close communication with Agassiz, Wyman, and Jackson. At first during this period his papers dealt with matters of geology and paleontology but later he took up work in physics. No discussion of these publications is here possible, but that they were of high character is conceded. Concerning a paper discussing the phenomena of smoke rings and rotating rings in liquids which was published in 1858, Cooke said: "In this paper Professor Rogers anticipated some of the later results of Helmholtz and Sir William Thompson."*

The crowning and greatest work of Professor Rogers' life was the founding of the Massachusetts Institute of Technology. That achievement was so important in its results, so far-reaching in its prospects, and so complete in its details, that it overshadows all else.

In 1859 [says Walker], Professor Rogers, gathering around him a number of the first citizens of Boston, begun the public discussion of a scheme for technical education, to be associated on one side, with research and original investigation upon the largest scale, and on the other, with agencies for the popular diffusion of useful knowledge. So entirely unfamiliar to the public mind of the day was the idea of technological instruction, beyond the simplest requirements of civil engineering, that the Legislature of Massachusetts could not be brought to see the full merits of Professor Rogers' most comprehensive and as all now view it thor-

* Life and Letters, Vol. II., p. 325.

* Cooke's Notice of Rogers, p. 433.

oughly practical plan, but enough was done by the Legislature during the few years following to secure the chartering, in 1862 and the inauguration in 1865 of the Massachusetts Institute of Technology of which Professor Rogers became the first president, devoting to it all the energy and enthusiasm of his impulsive nature and all the varied wealth of his accomplishments and acquirements. For the rest of his life this was chosen work.*

Rogers lived to transfer to a worthy successor the completed edifice—well established and equipped—an enduring monument to the nobility of character and the consecration of talents. Honored and loved by his associates and students, he came to be recognized as "founder and father perpetual, by a patent indefeasible." †

Of all the delightful memories of the Boston meeting in 1880 the meeting with Rogers is my pleasantest recollection. He was the central figure, losing no opportunity to make that meeting the greatest one in the history of our association. Never shall I forget when he rose

> Tall in stature, with a figure of the type known to us through the pictures of Henry Clay; with a face destitute of all assumption or arrogance, was singularly commanding; with a voice whose compass and quality were capable of producing at once the largest and the finest effects of speech.‡

and bade the Association welcome. He said:

> I thank my friends for the patience with which they have listened to one who does not like to call himself an old man, but who feels something of the spirit of the war-worn soldier, who likes at times to shoulder his crutch and fight his battles over again.§

Two years later, at the same place, he rose to address the graduating class of the Institute.

> His voice was at first weak and faltering but, as was his wont, he gathered inspiration from his theme, and for the moment his voice rang out in its full volume and in those well-remembered, most thrilling tones; then, of a sudden, there was silence in the midst of speech; that stately figure suddenly drooped; the fire died out of that eye, ever so quick to kindle at noble thoughts, and, before one of his attentive listeners had time to suspect the cause, he fell to the platform—instantly dead. All his life he had borne himself most faithfully and heroically, and he died as so good a knight would surely have wished, in harness, at his post; and in the very part and act of public duty.*

At the Buffalo meeting, in 1876, Simon Newcomb, 'one of the most celebrated astronomers of our time,' was chosen to preside over the Nashville meeting. Newcomb still lives and is our senior past president. He marks the dividing line between our earlier and later presidents.†

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM.

* Biographical Memoirs, p. 11.

† Cooke's Notice of Rogers, p. 427.

‡ Biographical Memoirs, by Walker, p. 5.

§ Proceedings, American Association for the Advancement of Science, Vol. XXIX., 1880, p. 739.

* Biographical Memoirs, by Walker, p. 13.

† Nature, Vol. LX., p. 1, May 4, 1899.

THE SENSE OF HEARING IN ANTS.

FOR many years it has been the generally accepted opinion of naturalists that ants do not possess a sense of hearing, at least within the range of sounds perceptible to the human ear. This opinion has been based upon the failure of the experiments along this line to show any effect whatever of the loudest and shrillest noises upon the ants with which they have been tried. Foremost among the scientists who have investigated this subject may be mentioned Lubbock, Huber and Forel, whose results have all been negative.

I am not prepared to explain why the results heretofore obtained have been so decidedly negative, while those described in this article are so decidedly affirmative, unless it may be that these particular species have never been experimented upon

before. The results of these experiments can merely be stated, and the conclusions to be drawn from them left to the mind of the reader.

Only four species of ants were concerned in the experiments: *Lasius americanus* and *Formica nitidiventris*, both belonging to the family FORMICIDÆ, and *Cremastogaster lineolata* and a species of the genus *Aphænogaster*, belonging to the MYRMICIDÆ. From the affirmative results obtained from these four species, even if they were absolutely certain, we could not, of course, draw any certain affirmative conclusions as to the whole group of ants; but even these few results are at least a favorable indication.

The experiments were performed both upon individuals and upon whole colonies. As there were about eighty experiments recorded for the four species, I can describe only a few of them and make general statements as to the others. The following are extracts from my notebook, and are significant in themselves.

Cremastogaster lineolata.

(1) May 2, 1899, 10:45 a. m. Ant wandering about isolated. I struck a steel sounding-bar of vibration-number 4096 (complete vibrations). Ant immediately raised its head and waved the antennæ.

(2) 10:56. Ant moving left front leg. Blew several blasts on a small bottle, being very careful not to blow upon the ant. Ant drew back the antennæ and began waving them immediately.

(3) 11:00. Same conditions. Struck the sounding-bar as in (1). Ant turned head and antennæ *toward the bar*, waving the antennæ slightly.

Another individual, same species.

(4) May 2, 5:05 p. m. Ant perfectly quiet. Blew short blasts on a small bottle, as in (2). Ant raised its head and waved the antennæ.

(5) 5:09. Same conditions. Blew a long, steady blast on a shrill wooden whistle. Ant began waving antennæ violently and kicking with one leg.

(6) 5:25. Ant walking along slowly on a strip of paper. Blew a shrill blast on a tin whistle. Ant started forward suddenly and walked faster.

(7) 5:29. Ant quiet. Blew a long blast on the shrill wooden whistle. Ant turned nearly half way around *toward the whistle*, waving the antennæ.

(8) 5:31. Ant quiet. Blew a short blast on the wooden whistle. Ant raised the antennæ high in the air and moved the abdomen up and down several times.

(9) 5:32. Ant quiet, facing me. Same experiment. Ant started *backward* suddenly and then began waving the antennæ.

Another individual, same species.

(10) May 4, 10:18 a. m. Ant quiet. Struck a tuning-fork (key middle A) and touched it several times to a piece of cardboard suspended in the air about two inches above the ant, making clear sounds. Ant raised the antennæ slightly at each sound.

Lasius americanus.

(11) May 8, 11:08 a. m. Ant walking along on a piece of paper. Touched a tuning-fork, as in (10), to a card a little in front of the ant. Ant immediately turned around and walked *in the opposite direction.*

Another individual, same species.

(12) May 11, 10:48 a. m. Ant wandering about isolated. Touched a card several times to a rapidly rotating milled disk near the ant, producing loud sounds. Ant walked more slowly, apparently crouching down, but occasionally starting forward as the sounds became more piercing.

Aphænogaster sp.

(13) May 19, 3:18 p. m. Ant perfectly quiet, confined by loose cotton in a test-tube. Suspended the tube in the air near the steel sounding-bar mentioned in (1) and struck the bar several times. Ant first

moved the antennæ, then the head, then the thorax, to and fro, and finally began to walk.

Formica nitidiventris.

(14) May 19, 4:08 p. m. Ant quiet, and confined in a test-tube as described in (13). Suspended the tube in the air near the rotating milled disk (12). At each sound from this apparatus the ant showed unmistakable signs of agitation, quickly moving the head and antennæ.

In addition to these, I may also mention an experiment tried on the colony as a whole with each of these species except *Formica nitidiventris*, with which I had no opportunity to try it. The colony being quiet in their nest under a plate of glass, I produced with the lips or with an instrument clear, shrill notes, taking the greatest care not to blow upon the nest or to allow anything else but the sound to disturb the colony. The ants instantly showed, by their quick movements in all directions, unmistakable signs of excitement or alarm. I tried this over and over again with each of the three species, in the presence of visitors to the laboratory, and the result was invariably the same. All who saw it admitted at once that their doubts as to the sense of hearing in those ants were entirely removed.

As to the remainder of the experiments, lack of space prevents me from describing them, but let it suffice to say that by far the greater part of them gave results just such as those already described.

The persistence of these affirmative results led me to a conclusion which is embodied in the statement of the following thesis: *The ants, or at least some of the ants, are capable of perceiving vibrations, conducted through the air or other media, which are audible as sound to the human ear.* It will be noticed that I do not assert that any of the ants *hear*, in the ordinary sense of the word; neither do I deny it; my statement is merely that some of them are capable of *perceiving* ordinary sound vibrations, which does not necessarily imply a true sense of hearing. However, in all the experiments, great care was taken in various ways to prevent the vibrations from reaching the ants through solids as media. And if it be true that this sensation, apparently due to a sense of hearing, is merely that of a mechanical vibration or jarring produced by the sound waves (and hence would pertain in a measure to the sense of touch), how shall we explain the results of experiments like (3), (7), (9) and (11), which certainly indicate a sense of direction? And how shall we account for the fact, shown in many of my experiments, that some ants which pay little attention to being knocked and jarred about in their glass prisons are driven nearly frantic, apparently, by shrill sounds? The result of experiment (8) should also be noted as of special importance. For this ant (*Cremastogaster lineolata*) is a stridulating species, and the movement of the abdomen mentioned is one of stridulation, producing a minute sound; the significance of this fact is obvious, indicating a response on the part of the ant to the sound of the whistle.

I might proceed to discuss at length the results of these experiments, arguing from standpoints based on the principles of psychology; but for the present it will be necessary, as before stated, to leave the experiments with their results as described to the consideration of the reader, and permit him to deduce his own conclusions.

Le Roy D. Weld.

Iowa State University.

*ARE THE TREES ADVANCING OR RETREATING UPON THE NEBRASKA PLAINS?**

Two years ago I presented a paper before this Section showing that there are reasons

* Read before Section G, Botany, of the American Association for the Advancement of Science, August, 1899.

for believing that the pines of Western Nebraska are advancing eastward in places where the fires have been kept out, and where cattle are not allowed to destroy, and man is himself not too actively engaged in the work of forest destruction. I have made further observations on these western pines, and while I have no doubt that there are places where they are dying out, I am certain that the general rule is that in western Nebraska and portions, at least, of the Black Hills of South Dakota, they are tending to advance, and that in many places they are actually advancing at a rate sufficiently rapid to be easily observed.

I have been studying the tree areas of eastern Nebraska, also, and find evidence which is still more conclusive that they are advancing with a good deal of rapidity. My personal observations have been in so many localities that it is impossible to specify them in detail in this paper. They involve most of the counties in eastern Nebraska. In practically every case where our travels up the streams, passing out to the side branches, to the little temporary rills which water the upper basins, the trees are of smaller size, and are much younger. It is a very rare occurence to find large trees near the upper end of a forest belt. I have seen a few of such cases, but their rarity is such that one is always surprised when they are found. The general rule is that near the upper limit of the tree area there are many shrubs and mingled with them many young trees no larger than those which under cultivation are known to be not more than fifteen to twenty years old. I may cite the following localities from my notes: (1) on the head waters of Oak Creek in Butler County, (2) headwaters of the Blue River in Seward and Hamilton counties, (3) headwaters of Weeping Water Creek, in Cass County, (4) along small streams in the Loup Valley, (5) along the small streams north of the Platte in Sarpy County, (6) headwaters of the little Nemaha Creek in Nemaha County.

I have asked some of the older settlers of the State in regard to this matter, and invariably they tell me that the trees have advanced up the valleys. One man says: "in our neighborhood the native timber has crept up the water courses in some places a mile or more, and in other places it has widened out from near the stream banks," and again in referring to a particular spreading area he says: "in the places where we played in the 'buffalo wallow' twenty-five years ago, there are now many large trees."

Another says that in 1872 very few of the 'draws' (*i. e.*, ravines) had any trees in them, but now where fire is kept out all are filled with timber. He says that on his farm which was originally swept with prairie fires, "I had a 'draw' where water was half the year, in which in 1883 there were no trees of any kind, while now there are willow, cottonwood, box elder and elms," and again, "the timber belt along the Nemaha River has widened from a hundred feet to half a mile and in some of the 'draws' it has run up from half a mile to a mile."

Another man speaks of a spot where "there is at present a fine lot of young timber of oak and hickory, where in 1876 there was nothing but brush; it is fully one hundred yards further up the stream than it was in 1876." He cites another case where the timber area has gone 'nearly half a mile up the stream.' He says that a fine grove of native timber through which I had passed a day or two before "was a brush patch in 1874, very few of the trees then being large enough for fishing poles," while now many of the trees are thirty or or more centimeters in diameter.

Another observer records a grove consisting principally of oak trees from 15 to 30 centimeters in diameter and 18 to 20 me-

ters in height, occupying an area which a little more than forty years ago the owner used for a hay meadow.

I need not cite further cases. No one who has seen and studied the forest areas in eastern Nebraska, will be able to doubt that they are spreading where they are given a fair opportunity and are not prevented by man or his domestic animals.

Charles E. Bessey.
The University of Nebraska.

PRELIMINARY NOTE ON NEW METEORITES FROM ALLEGAN, MICHIGAN AND MART, TEXAS.

A little after 8 o'clock on the morning of July 10, 1899, there fell on what is locally known as Thomas Hill, on the Saugatuck road, in Allegan, Michigan, a stony meteorite, the total weight of which cannot have been far from 70 pounds, although unfortunately it was badly shattered in striking the ground and its exact weight can never be known. The main mass of the stone, which came into the possession of the National Museum, weighed 62½ pounds, with an additional fragment weighing about 1½ pounds. These with a 4 pound fragment sold to other parties, and very many small bits stated as varying from the size of a pea to that of a hickory nut, carried away by school children and others, would readily bring the total weight up to the figure mentioned. According to the as yet unverified statement of a paper, the fall was accompanied by a 'sudden report, like that of a distant cannon,' this being immediately followed by a rumbling rushing noise similar to distant thunder with the addition of a hissing noise. Eye witnesses of the fall describe the stone as descending in a nearly vertical direction with an apparently slight incline from north to west. A slight bluish tinge and hazy appearance was noted, but no luminosity, though that the stone must have been highly heated in its passage through the atmosphere is proven by its being completely covered by a beautiful black crust, of about 2 mm. thickness. However this may be it was evidently scarcely more than warm when it reached the surface of the ground, for fibers of dry grass, leaves and roots which became firmly attached to its surface through impact, or even driven into crevices formed by the shock of striking the ground, were not charred in the least. The stone is reported to have been about 18 inches long and 12 inches thick, and to have buried itself in the ground by 18 inches where it fell. It was immediately exhumed, and is stated to have been 'still warm' when placed in the show windows of Messrs. Stern & Company, local clothing dealers.

The stone as received at the Museum is polyhedral in outline, one end badly shattered, the larger surfaces often somewhat convex, and as above noted covered with a thin black crust which is irregularly checked by contraction and the shock of the fall. The structure is chondritic, and the essential constituents olivine and an orthorhombic pyroxene (enstatite), together with very finely disseminated metallic iron and undetermined sulphides. A causal inspection fails to make certain the presence of feldspars. The stone therefore belongs to group 29, Kügelchen Chondrit (Cc), of Brezina. The texture is very fine, and uniform throughout, the chondrules, often beautiful spherical, rarely exceeding 2 mm. in diameter. These are sometimes wholly of radiating enstatites, or again of idiomorphic olivines in a black glass. The mass is very friable, and though beautifully fresh and unoxidized, falls away readily to sand when pressed between the thumb and fingers.

As stated in Science for November 10th, the stone will be analyzed and studied microscropically, after which it will be in

part broken up and offered in exchange for other materials of like nature. It will be known as the Allegan meteorite.

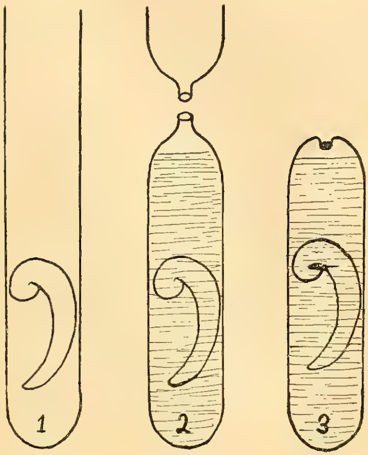
The second meteorite to which I have referred, is an iron, the main mass of which is now in the possession of Baylor University, Waco, Texas. It was found early in 1898, on Vaughn's farm, near Mart, in McLennan County. The iron weighed originally 19¾ pounds. The shape is an irregular oval, some 21.5 x 15 x 8.5 mm. in greatest dimensions, with two deep pits on one side. It was not seen to fall and is somewhat oxidized exteriorly. When cut and etched it shows well the Widmanstätten figures, and the presence of numerous spots of troilite scarcely a millimeter in diameter. This will be known as the Mart iron. Both the iron and the Allegan stone will be analyzed in the laboratories of the United States Geological Survey.

GEORGE P. MERRILL.

PERMANENT PREPARATIONS IN HERMETICALLY SEALED TUBES.

THE method of keeping various animals for demonstration and illustration in hermetically sealed tubes here to be noted has been in use in my laboratory for several years and proven itself so convenient and useful that I feel if it has ever been advocated before (of which I am not cognizant), it deserves revival, hence this note.

In brief the method is as follows: Glass tubing of a size just admitting the specimen is selected considerably longer than the final sealed tube is to be. One end is closed with or without a foot. The tube is then filled with 80% (or 70%) alcohol and the specimen is introduced, allowing it to drop down or carefully working it down the tube. Nearly all the alcohol is then poured off (Fig. 1). Specimens too delicate to admit of this must, of course, be kept covered with alcohol and the final tube be somewhat longer than necessary. The tube is now drawn to a point at some distance from the object and is broken off at the narrow neck (Fig. 2) so as to leave as small an opening as possible through which the tube can be filled up to or even above the shoulder of the drawn end. When the tube is filled the end is sealed in the Bunsen flame (Fig. 3). For filling the tube



finally one needs a 'tube-funnel' with a long small end that can be inserted into the neck of the tube.

Care must be taken to get the tube out of the flame before the expansion of the vapors becomes too great. When quickly done the sealed end will often be invaginated by the pressure from without, thus making an end not liable to have the button or bead broken off. In heating the tube after it has contained alcohol inflammable vapors will, of course, be formed. These are usually driven off with an explosion that one soon learns is not at all dangerous.

The secret of success lies in as small a neck as will admit filling and a strong heat applied quickly at the very end.

I have found Flemming's mixture of alcohol, glycerine and water usually better than pure alcohol. This mixture vaporizes less rapidly and as is well known keeps objects in excellent consistency.

For objects to be viewed only from one side or where two specimens, one for a dorsal view and one for a ventral view, can be used, the introduction of a strip of milky or black glass as wide as the diameter of the tube or a trifle less is an improvement for observation.

The method is of special value in the laboratory and lecture room. For toto specimens of animals (or organs admitting of this treatment) to be used by large classes it is excellent. The specimens can be examined closely and can be handled freely without danger of being ruined. In no other way known to me can medusæ, ctenophora and similar delicate animals be handled and studied so freely without injury to the specimen. Moreover, magnifying glasses can be used very easily and profitably.

Even many museum specimens can be thus preserved permanently and relieve the curator of the dread of a possible evaporation. Dr. MacDougal has found the method admirably adapted to many things in botany.

In the study of the embryology of many animals material thus preserved is of great value. The various stages thus preserved are marked in agreement with the series of sections of corresponding stages. In many cases the specimens can be stained and put up in balsam or damar or any other mounting medium for transparent objects. Such preparations in connection with serial sections are often invaluable and to the student are always a help well worth having on hand.

After I had used round tubing for some time it occurred to me oval tubing might be better because it would magnify and distort the objects less. The experiments made with large pig and chick embryos do not, however, favor the oval tubing, which, moreover, is more expensive than the circular tubing. Professor MacDougal, however, prefers it for some of his plant preparations.

Various details, such as mounting and labelling the tubes for the museum, suspending the specimen by means of a fine wire, etc., must be left to individual genius, likes and dislikes.

Henry F. Nachtrieb.

University of Minnesota.

SCIENTIFIC BOOKS.

Methods of Knowledge; an Essay in Epistemology. By Walter Smith, Ph.D., Professor of Philosophy in Lake Forest University. New York, The Macmillan Co. 1899. 12mo. Pp. xxii + 340.

Although Locke must be regarded as the founder of the philosophical discipline known variously as Epistemology, Noëtics, Theory of Knowledge, it remains true that thinkers who use English have lagged behind their German brethren in cultivating its special field. Thanks to Kant, to the renewed interest in his work after 1860, and to the direct influence of the particular sciences—which brought German thought back to Locke just at the moment when Britain and the United States were going to school with Hegel—Epistemology achieved an importance through writers like Schuppe, Cohen, Riehl, Avenarius, Busse, and to some extent, Lotze and Wundt, such as it has never enjoyed with us, and in all likelihood, will not soon gain. Professor Smith's work has, therefore, a place to fill; moreover, the author succeeds in presenting some fresh, if not striking, ideas.

Yet, no matter how favorably one may be inclined to view it, Epistemology suffers still from several capital defects. The delimitation of its precise sphere cannot be called complete by any means. Its relation to logic remains a moot point. Its commerce with psychology, and particularly its debt to psychological methods are undetermined or, at all events, subject to large variation of view. While, once more, even British experts, who have not found so much reason to trouble about its province as their German colleagues, have deemed it necessary to execute some excellent wrangling over its relation to metaphysics. Traces of this dispute remain in the work before us. The weaknesses of Dr. Smith's book appear to be direct products of the two last points. His epistemology, by accident or design I cannot profess to determine, overlaps the psychological sphere extensively. Possibly, one ought to forgive this tendency, because it imparts concreteness to abstract investigations of an exceedingly difficult kind. Again, his conception of the rela-

tion of epistemology to metaphysics, in so far as it crops out, seems to me to be of a distinctively dogmatic character; dogmatic in the pre-Kantian sense. But this criticism, as Dr. Smith, and everybody else must be aware, depends greatly on point of view. And for myself, I am unable to see how epistemology and metaphysics can be disjoined as they appear disjoined here; especially, I must demur strongly to Dr. Smith's pronounced tendency to substitute epistemology for metaphysics in relation to some fundamental problems. I am aware that this is a popular direction at present; but this only emphasizes its temporary character.

The central portion of the work consists of a plain, straight-forward consideration of what might be called the law of homology, in some of its psychological aspects. 'Like is known by like,' and therefore, 'sympathetic imitation' must be regarded as the main and most adequate method of knowledge. Throughout this discussion the proper problem of epistemology, that of the relativity of human knowledge, is submerged, and a factor in experience, which no one would seek to deny, but which falls essentially within the purview of psychology, is put forward as if it furnished at once the ideal and the method. Knowledge is defined as "the presence in the mind immediately, or in copy of that which constitutes objects" (35), evidently on the tacit understanding that this position does not involve dualism, with its resultant scepticism. Just before enunciating this definition, Dr. Smith sums up the merits and defects of other theories of knowledge, without suspecting, however, that the emphasis on the one hand, between subject and object as different, and on the other, the stress on self-knowledge can be traced to an ultimate relativity, a *datum*, if you please so to call it, which is at once the justification of the existence of epistemology and the source of its problem. The dualistic implications of Dr. Smith's standpoint make themselves felt, and naturally, all through. Towards the close they at length become quite explicit. "It is the function of knowledge to equate itself with its object" (266); and on the next page, Dr. Smith quotes, with apparent approval, Mr. Spencer's declaration, "the perception of relations is not the perception of the things themselves." Provided 'perception' be taken in the same sense in both clauses, can such a form of words be said to express anything thinkable by man? Just because epistemology *is* a science with a problem and a solution for it, things cannot be set over against relations and apart from them in this airy fashion.

Although the book is not an epistemology and even illustrates a kind of philosophical backsliding, sporadic now, it presents its good points. The chapter on 'Sympathetic Imitation in Art' contains some admirable reflections; the fatality of hurried systematization is pressed home well, and the entire argument is marked by the presence of an all-round culture very refreshing in these days of one-eyed specializing. As has been indicated, Dr. Smith has not embraced the inviting opportunity to contribute an authoritative work in English to epistemology. He has done appreciable service, nevertheless, by entering a series of *caveats* which some eager spirits would do well to bear in vivid remembrance.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

Die Kontinuität der Atomverkettung ein Strukturprinzip der lebendigen Substanz. By DR. GEORG HÖRMANN. Jena, Gustav Fischer. 1899. 3 M.

That such structures as nerves, or even an entire animal, might be regarded as single, huge, chemical molecules was an hypothesis advanced by E. Pflüger a quarter of a century ago. Observation and speculation since have almost unanimously tended toward the prevalent morphological conception of living matter as an aggregate of separate units, while Pflüger's idea has lacked support. In the present essay we find an interesting attempt to extend and to develop Pflüger's hypothesis by logical reasoning illustrated by diagrams.

The author would have protoplasm a net work composed of living matter, with its meshes filled by the various liquids, etc., that go to make up the complex whole.

This network is molecular, invisible, purely hypothetical. The living part of organisms is,

in a sense, solid not liquid; but as it is made up of atoms joined into the molecular meshwork only by their mutual chemical affinities, it is possible for various physical agents to interrupt the continuity of the mass and to make it act somewhat in the manner of a liquid, to become subject to surface tension laws, etc. The solidity is not that of cohesion, but only the result of the chemical attractions that tend to hold together the elements in the complex molecular net against forces that might tend to disturb the continuity.

A cell is a continuous net work made of molecules joined in chains; the members of the chains are different within the nucleus from those outside the nucleus, but there is no break in continuity from one region to the other.

Approaching the problem from the physiologist's point of view, the author devotes his discussion chiefly to phenomena of nerve, muscle, and electrical organ. A nerve is conceived as containing rows of living, conductive molecules surrounded by various liquid and emulsive substances. Each component molecule is joined to its fellows in the row by the affinity of some of its atoms. Progressive chemical action between successive molecules in the chain and the environing materials constitutes the change that travels as a nerve impulse.

In muscle similar chains of conducting molecules have connected with them, as additional mechanisms, special contractile molecules, which owe their change of shape to chemical rearrangements.

Electrical organs easily lend themselves to an application of similar diagrammatic formulations.

Strange as it may seem the phenomena of the active flowing of protoplasmic streams in those exceptional water-plants, Stoneworts, are made foundation stones in the author's attempt to realize protoplasm as a solid, continuous, gigantic molecule. His previous valuable contribution to the physiology of these plants (Studien über die Protoplasmaströmung bei den Characeen. Jena, Gustav Fischer. 1898) resulted in the discovery of marked agreement in the conductive mechanisms in nerve, muscle and the cells of *Nitella syncarpa*. The motor mechanism in the last, however, he concludes, is different from that in muscle. Both the constant rotation of the moving layer of protoplasm and the very remarkable separate rotation of separate chlorophyll grains, which the author is sure he has seen, are conceived of as results of successive making and breaking of chemical union along the surface of contact of moving and non-moving protoplasm.

E. A. Andrews.

Johns Hopkins University.

A Dictionary of Birds. By Alfred Newton, assisted by Hans Gadow. Cheap issue, unabridged. London, Adam and Charles Black. 1893–96. Pp. xii + 1088. Price, $5.00.

Good wine needs no bush and Newton's Dictionary of Birds needs no recommendation, the more that it was fully reviewed in Science upon its first appearance.

There are, however, many who will welcome this edition, not only for its greatly reduced price, but for its convenient size, since without sacrificing a word of the text the use of thin, but good paper, makes this book a compact volume. Few there are who have Professor Newton's wide acquaintance with the literature of ornithology and the bibliographical references alone are sufficient to make the work a necessity, not only in the library of the working ornithologist, but of the general reader, while the contributions of Dr. Gadow constitute a text-book on the anatomy of birds. Our younger ornithologists will do well to keep this book within reach and consult it often, if only to fully appreciate that scientific facts may be presented in the best literary form.

F. A. L.

BOOKS RECEIVED.

A Treatise on Crystallography. W. J. Lewis. Cambridge, England, University Press. 1899. Pp. xxii + 612. 14s.

The Strength of Materials. J. A. Ewing. Pp. xii + 246. Cambridge, England, University Press. 1899. Pp. xxii + 612. 12s.

Electric Wiring, Fittings, Switches and Lamps. W. Perren Maycock. London, Whittaker & Co.; New York, The Macmillan Co. 1899. Pp. xv + 446. $1.75.

Botany for Beginners. ERNEST EVANS. London and New York, The Macmillan Company. 1899. Pp. vi + 286.

Magnetism and Electricity for Beginners. H. E. HADLEY. London and New York, The Macmillan Company. 1899. Pp. viii + 327.

Ascidia. W. A. HERDMAN. Liverpool Marine Biology, Memoirs I. Liverpool, T. Dobb & Co. 1899. Pp. v + 52 and 5 plates. 1s. 6d.

Report of Fur Seal Investigation, 1896–1897. Part III. *Special Papers relating to the Fur Seal and to the Natural History of the Pribilof Islands.* DAVID STARR JORDAN. Washington, Government Printing Office. 1899. Pp. xii + 629.

On the Building and Ornamental Stones of Wisconsin. ERNEST ROBERTSON BUCKLEY. Madison, Wis., Published by the State. 1898. Pp. xxvii + 544.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology for July–August contains the following articles:

'A new Analcite Rock from Lake Superior,' by A. P. Coleman. On the north shore of Lake Superior in the vicinity of Heron Bay, Dr. Coleman recently discovered a series of dikes, one of which proved to be an analcite rock. It has some peculiarities of texture, contains about 52 per cent. silica, and is related to basic syenites. The name Heronite is suggested. A complete analysis is given.

'Corundiferous Nepheline Syenite from Eastern Ontario,' by A. P. Coleman. Dr. Coleman gives some additional notes and facts about this peculiar rock.

'The Effect of Sea-Barriers upon Ultimate Drainage,' by J. F. Newsom. This very interesting and suggestive paper shows how the barrier beaches and their attendant sounds may, when the coast line is elevated, cause the main artery of the resulting drainage to run parallel with them, and at right angles to the subordinate tributaries.

'Season and Time-elements in Sand-plain formation,' by Myron L. Fuller. From a close study and very ingenious interpretation of the Barrington sand-plain and its attendant clays, on Narragansett Bay, R. I., and with auxiliary inferences about the effects of the seasons on the discharge of a glacier, the author makes a computation of the time required to yield the observed phenomena. The results check up very well with general criteria, and the paper is an interesting attempt to give quantitative definition to otherwise hazy themes.

'Petrographical Province of Essex Co., Mass,' VI., 'General Discussion and Conclusions,' by H. S. Washington. In this the concluding instalment of the series of papers contributed by Dr. Washington to recent numbers of the *Journal of Geology*, the author generalizes regarding the peculiar chemical features and mineralogy of the Essex County rocks. He also discusses their bearings on the general question of magmatic differentiation. Dr. Washington concludes that differentiation occurred and that it was laccolithic rather than abysmal.

'A Peculiar Devonian Deposit in Northeastern Illinois,' by Stuart Weller. A small triangular mass of rock containing Devonian fossils has been uncovered in a quarry of Niagara limestone at Elmhurst, Ill. It appears to have been a hole in the limestone when the latter formed the sea bottom in Devonian time, and to have been a resort of fish whose remains have been preserved.

'Descriptions of New Species of Diplodus teeth from the Devonian of Northeastern Illinois,' by C. R. Eastman. The paper describes the fish, the discovery of whose remains is detailed in the previous paper.

'Dipterus in the American Middle Devonian,' by J. S. Udden. This short paper describes and figures a Dipterus tooth recently found in the limestones at Fairport, Muscatine Co., Iowa.

Under the 'Studies for Students,' Stuart Weller gives an excellent sketch of a 'Century's Progress in Paleontology.'

The number closes with editorials and reviews.

THE October number of the *Bulletin of the American Mathematical Society* contains a Report of the recent Summer Meeting of the Society, by the Acting Secretary, Professor Thomas F. Holgate; the 'Report on the Recent Progress in the Theory of Linear Groups,' presented before Section A, of the American Association, at the Columbus Meeting, by Professor L. E. Dickson; several 'Shorter Notices'; 'Notes'; and 'New Publications.'

The November number of the *Bulletin* contains a report of the meeting of Section A, of the American Association, by Dr. G. A. Miller; a review of Harkness and Morley's 'Introduction to the Theory of Functions,' by Professor Oskar Bolza; a review of McAulay's 'Octonions,' by Professor A. S. Hathaway; 'Theses in Mathematics at the University of Paris,' a review by Professor E. O. Lovett of five theses, presented to the Faculty of Sciences of the University of Paris, 1897–8; 'Notes'; 'New Publications.'

Bird-Lore for October contains an article by Dr. J. A. Allen on the *American Ornithologists' Union* illustrated by a full page plate showing the twenty-four founders of the Union. It contains portraits of Baird, Robert Ridgway, Elliott Coues, J. A. Allen, C. Hart Merriam, William Brewster and other prominent ornithologists.

It is stated in *Natural Science* that the Quebec government has withdrawn the grant made to defray the cost of publishing the *Canadian Record of Science*. The Natural History Society of Montreal appeals for help to continue the journal.

SOCIETIES AND ACADEMIES.

THE NATIONAL ACADEMY OF SCIENCES.

The Academy held its autumn session at Columbia University on Tuesday and Wednesday, November 14th and 15th, the following members being in attendance: Cleveland Abbe, George F. Barker, C. E. Beecher, A. Graham Bell, John S. Billings, Henry P. Bowditch, William H. Brewer, George J. Brush, Charles F. Chandler, Cyrus B. Comstock, Edward S. Dana, Samuel F. Emmons, Wolcott Gibbs, Arnold Hague, Charles S. Hastings, Edward S. Holden, Richmond Mayo-Smith, Albert A. Michelson, Simon Newcomb, Charles S. Peirce, Frederick W. Putnam, T. W. Richards, Ogden N. Rood, A. E. Verrill, Charles D. Walcott, E. B. Wilson, Horatio C. Wood, Robert S. Woodward and Arthur W. Wright.

At the business session Professor H. P. Bowditch presented the report of the delegates to the Wiesbaden Congress to consider the establishment of an International Scientific Association.

The scientific program was as follows:

Variations in Normal Color Vision, by Ogden N. Rood.

The Time of Perception as a Measure of Difference in Intensity; Relations of Time and Space in Vision (by invitation), by J. McKeen Cattell.

The Electro-chemical Equivalents of Copper and Silver, by Theodore William Richards.

Recent Results of the Henry Draper Memorial, by Edward C. Pickering. Read by Professor G. F. Barker.

The Statical Properties of the Atmosphere, by R. S. Woodward.

The Hydrogen Vacua of Dewar, by George F. Barker.

A Direct Proof of the Effect on the Eulerian Cycle of an Inequality in the Equatorial Moments of Inertia of the Earth, by R. S. Woodward.

The Definition of Continuity (by title); Topical Geometry, in General (by title): The Map-coloring Problem, by Charles S. Peirce.

Memoir of W. A. Rogers as a Physicist (by title), by E. W. Morley.

BIOLOGICAL SOCIETY OF WASHINGTON, 311TH MEETING, SATURDAY, NOVEMBER 4TH.

Dr. L. O. Howard, under the title 'Preliminary Notice of an Investigation of the Insect Fauna of Human Excrement,' exhibted a series of dipterous insects reared from human excrement, and stated that having been interested in the published accounts in the medical journals of the autumn of 1898 of the supposed carriage of typhoid germs by flies in army camps, and realizing that no careful investigation of the insect fauna of human excrement had been made by entomologists, he had begun such an investigation in January, 1899. During the year many thousands of specimens of insects had been reared from fecal matter, and had been collected in privies and on excreta in the field, largely in the vicinity of Washington, but also in other parts of the country at different points, from Porto Rico to the State of Washington. Up to the present time, 138 distinct species of insects had been determined to frequent human excrement, including 77 distinct species of *Diptera*,

and 45 distinct species of insects have been reared from the excrement in which they passed their larval stages, and these include 35 distinct species of *Diptera*. Similar collections and observations have been made upon flies frequenting kitchens and dining rooms in different parts of the country. All of the material has been studied and specifically determined. The investigation will be continued and the results published next year.

Mr. Wm. H. Dall gave some informal 'Notes on Honolulu and the Hawaiian Islands,' from observations made there during a recent visit. He described the physical features of Oahu and their effects upon the climate, the characteristics of the flora and fauna of the city of Honolulu, laying particular stress upon their almost exclusively exotic character, and gave an account of the Bishop Memorial Museum, an institution reflecting the greatest credit upon the founder who endowed it, the board who have managed the investments, and the Director, Dr. W. T. Brigham, to whose energy, efficiency and wide knowledge is largely due the fact that Honolulu now has a Museum of Polynesian Ethnology and Natural History in many respects unique and which would be a credit to any city in either hemisphere.

Mr. G. K. Gilbert described the state of preservation of the celebrated 'Submerged forest of the Columbia River,' between the Dalles and the Cascades. From data connected with the geological history of the region he inferred that the submergence had taken place at least three hundred and fifty years ago. Since that time the roots of the trees, whose stumps still stand, have been continuously under water, but the upper portions of the shafts have been annually bared at low water and covered during flood. Despite this alternation of condition, which generally induces rot, the trunks are sound. The bark has disappeared, and several inches of the wood have wasted away, but what remains is firm and retains its natural color. Mr. Gilbert suggested that the continuous submergence of the roots may have operated in some way as a favorable condition, but it was the opinion of botanists present that the roots must have ceased to function immediately upon the death of the tree, and that the preservation of the trunks was merely an extreme illustration of the durability of the wood of the species *Pseudotsuga douglasii*.

O. F. COOK,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 505th meeting of the Philosophical Society of Washington was held October 28th, at the Cosmos Club. Informal communications were made by Dr. Artemas Martin, on a method of extracting roots by successive subtractions and by Mr. C. K. Wead, on Museum Labels. The Director of the Geological Survey, Mr. C. D. Walcott, gave the results of his observations on a recent 'Geological Trip to Newfoundland,' and Mr. C. K. Wead described 'Some Arab Musical Scales.' The facts presented were made accessible by Land's French Translation of Al Farabi's 'Treatise on Music,' and confirmed in part by other authorities. The principal scale for the Lute was shown to be peculiarly dependent on the length of the neck of the instrument in comparison with the size of the player's hand: the five strings were tuned in fourths, and the frets were located partly by geometrical principles, and partly by bisections of distances; so ten notes were provided on each string, giving twenty-two to the octave. Later theorists reduced these numbers to seven and the much-discussed seventeen. The Modes each consisting of a selection of seven or eight of these notes were also dependent on the structure of the lute.

Some long-necked Tambours had entirely different scales tuned by the use of two strings, being built up by musical addition or subtraction of equal intervals, *i. e.*, by a step-by-step method—these scales had seven to ten notes at intervals of about half a semitone. Our current theories of the scale are utterly inapplicable to these facts.

E. D. PRESTON,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE NEED FOR A CLASSIFICATION OF PREHISTORIC IMPLEMENTS.

ABOUT a year ago Mr. A. E. Douglas, of the American Museum of Natural History, published a paper in which he urged the need of an

archæologic nomenclature. He presented a table in which he showed the distribution of certain types and forms of artifacts.

Dr. Thomas Wilson, of the Smithsonian, has issued a number of reports in which he classifies and subdivides the multitudinous flint tools of the United States. Aside from this and what has been done by Messrs. Holmes, Fowke, Rau, Abbott and others, the various museums and individuals have confined themselves to the chronicling of explorations rather than to the detailed study of objects. Some of the more remarkable art specimens in copper, clay and shell have been reported upon. But I think it is no exaggeration to say that museums direct their attention to the accumulation of vast stores of material. This is apparent to archæologists visiting any of the five larger museums.

I agree with Mr. Douglass that too little attention is given towards the study of these interesting implements. By comparison and a careful study of localities and the objects themselves, much is to be learned.

I have begun several MSS. upon 'ornamental and ceremonial stones,' and 'implements and utensils,' etc. I shall be glad to have photographs, drawings or descriptions, together with observations and opinions from persons interested in prehistoric archæology. I shall feel encouraged if a more serious study of stone, bone, shell and clay objects results from the undertaking, although other observers may take exceptions to my views. An exchange of correspondence is desired.

Warren K. Moorehead.

Saranac Lake, N. Y.

NOTES ON INORGANIC CHEMISTRY.

In the *Zeitschrift für praktische Geologie*, H. Oehmichen describes some recently discovered auriferous cobalt ores in the Kruis river district in the Transvaal. The ore, which is found associated with diabase rocks, is exclusively smaltite, with its decomposition products, as erythrite, and carries gold to the amount of about 60 grams per ton. The gold seems to be in the smaltite, as no trace of free gold is found. Five kilometers further west is another deposit of pockets of smaltite, in a gold bearing quartz, the whole assaying 400 grams per ton. Here ninety per cent. of the gold is contained in the smaltite. These deposits promise to have a very considerable value.

The subject of the distribution of the so-called rare metals continues to interest chemists and in the same journal is an extensive paper by J. H. L. Vogt on the distribution of vanadium. A very considerable portion of the paper is taken up by a review of Hillebrand's paper (published last year in the *American Journal of Science*) on the same subject. From Hillebrand's investigations and his own, Vogt concludes that the average amount of vanadium in the solid crust of the earth is between 0.0025% and 0.005%. Vanadium is thus decidedly less abundant than titanium (which occurs to the extent of 0.3%), phosphorus (0.09%), manganese (0.075%) and sulfur (0.06%); and also rarer than barium (0.03%), zirconium (0.01–0.02%) and chromium (0.01%). It falls near lithium, strontium and nickel, each of which occurs to the extent of about 0.005%, but is probably somewhat less abundant than these elements. Still rarer elements are cerium and yttrium (each less than 0.001%), cobalt (0.0005%) and thorium (0.0001%). Zinc and glucinum are somewhat less rare. Vanadium is generally found in the basic eruptive rocks, while columbium and tantalum, which resemble it are found especially in granitic rocks. The elements of Group VI. show a similar condition, for chromium is found in basic rocks, while molybdenum, tungsten and uranium are more generally associated with acidic rock masses. It might be added that these occurrences are not unnatural, inasmuch as vanadium and chromium are themselves much less positive than the elements of the same groups with higher atomic weight.

There is given in a recent number of the *Oesterreichische Zeitschrift für Berg- und Hüttenwesen* a description by E. Priwoznik of the Austrian mint methods of parting platiniferous gold and silver. The material is first digested with dilute nitric acid (1.109) in which only a trace of platinum dissolves. The residue is then treated with a somewhat diluted aqua regia in which the gold dissolves readily, while the platinum is only very slightly soluble. When silver is present a coating of silver chloride is gradu-

ally formed which impedes the solution of the gold. In this case the silver chlorid coating must be from time to time dissolved off by ammonia. The small amount of platinum in the gold solution is precipitated by sal ammoniac. When much silver is present the alloy is fused with zinc and then treated with sulfuric acid before the above process.

THE atomic weight of palladium has been several times redetermined in the past few years, but with results varying from 105.75 to 107.18. No cause has been discovered for these discrepancies. The figure accepted by Clark is 106.36, by Richards 106.5, and by the German Committee 106.0. Three new series are described by W. L Hardin in the *Journal* of the American Chemical Society, in each case the compound used being one not hitherto used for atomic weight determination. The palladium itself was most carefully purified. The results are as follows: Using diphenylpallad-diammonium chlorid, mean of seven determinations 107.006; using diphenylpallad-ammonium bromid, mean of five, 107.036; using ammonium palladium bromid, mean of four, 107.00; mean of all, 107.014. It will be seen that this figure is decidedly higher than that usually received; it is, however, in close agreement with that obtained by Keller and Smith (107.18 as a mean of nine determinations) by the use of pallad-diammonium chlorid.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

INTERNATIONAL METEOROLOGICAL COMMITTEE.

AT the meeting of the International Meteorological Committee held at St. Petersburg, September 2–7, 1899, it was decided that the Sub-Committee on Terrestrial Magnetism and Atmospheric Electricity should be maintained as a distinct organization, under the direction of the International Committee. The committee recommended that meteorological institutions should take part in observations of earthquake phenomena, and in the matter of Antarctic exploration expressed the opinion that it is highly desirable (1) that the results of these explorations should be completed by data from the observatories already existing in the Southern Hemisphere and by those made on board vessels traversing the southern oceans; (2) that new meteorological stations should be established in the southern part of the Antarctic regions, and especially that magnetic observations should be organized; (3) that magnetic determinations over the whole globe should be made simultaneously with those made during the expeditions. The subjects of publishing tables of diurnal range of temperature for each country in a special form, the importance of actinometric observations, the multiplication of observations with the hair hygrometer in place of the wet-bulb thermometer, the laying of a cable between Iceland and Europe, and the publication of an international periodical weather report to contain ten-days means for about 100 stations, were discussed, but no definite action was taken regarding them. It was decided that the International Committee and all the sub-committees should meet in Paris in 1900, immediately after the Meteorological Congress. *Nature* of October 19th contains a brief account of the Proceedings at the September Meeting of the International Committee.

THE TEXAS FLOODS OF JUNE 27 TO JULY 15.

A report on the flood in the Brazos river valley, Texas, at the end of June and the beginning of July last appears in the *Monthly Weather Review* for July (issued September 22d). The writer, Dr. I. M. Cline, Local Forecast Official of the Weather Bureau at Galveston, states that the heavy rains resulted from a semi-tropical storm which moved northward from the central portion of the Gulf of Mexico. The storm was first noted on the morning weather map of June 26th, and moved inland during the night, dying out as it advanced. An anticyclone moving southward from the northwest opposed the Gulf storm on June 27–28, these being the pressure conditions which prevailed during the occurrence of the rains. Two of the heaviest rains recorded during the 72 hours ending at 8 A. M., June 28th, were as follows: Alvin, 7.27 ins.; Brazoria, 7.83 ins. During the 72 hours ending at 8 A. M., June 29th, some of the heaviest rainfalls were: Columbia, 8.06 ins.; Danevang, 11.07 ins.; Rock Island, 10.15 ins., and during the 72 hours ending at 8 A. M., June 30th, Brenham had 19.99 ins.

The rain gauge at Hearne overflowed at 24 inches. The floods resulting from these extraordinary rainfalls were extremely destructive, as readers of SCIENCE will doubtless remember. Between 30 and 35 lives were lost, and crops and other interests suffered to the extent of millions of dollars.

VOLCANIC SMOKE AND THE PREVAILING WINDS.

The *Monthly Weather Review* for July contains an interesting note contributed by Curtis J. Lyons, of Honolulu, on the course taken by the smoke during the recent eruption on the island of Hawaii. This smoke rose to a height of about 30,000 ft. above sea level, and then floated off to the northeast, being carried in a horizontal direction by the anti-trades. It then sank to sea level about 600 miles from Hawaii, and was brought back by the northeast trade wind, covering the entire group of islands with heavy smoke fourteen days after the eruption. The S. S. *Mariposa*, on her voyage from San Francisco, met the cloud of smoke at the above distance from Honolulu. The smoke was overhead at first, and as the steamer proceeded it covered everything at sea level.

HURRICANE TRACKS IN THE NORTH ATLANTIC OCEAN.

The *Pilot Chart of the North Atlantic Ocean* for November gives the tracks followed by the centers of all the West Indian hurricanes which have occurred in the North Atlantic during the period 1890–1899. It appears from a tabulation of the 25 hurricanes noted during these years that the ideas which were formerly held regarding the recurvature of the storms of a particular month within certain narrow limits of latitude need some revision. The table shows that the hurricanes of September, instead of recurving between latitudes 27° and 29°, as formerly maintained, may in actual practice recurve in any latitude from 20° 20′ N., to 33° 30′ N., while those of October, instead of recurving in latitude 20°–23° N. may continue their northeasterly course until the parallel of 39° is reached.

TORNADO POWER.

As the result of studies of the amount of pressure necessary to bend the rods of certain railroad switch targets, Mr. B. F. Groat comes to the conclusion that the velocity of the wind in the New Richmond, Wis., tornado of June 12th last was 134 miles an hour. Mr. Groat's paper is published in the *Monthly Weather Review* for July.

R. DeC. WARD.

HARVARD UNIVERSITY.

REPORT OF THE PRESIDENT OF COLUMBIA UNIVERSITY.

President Low's annual report to the trustees, after paying a tribute to the memory of Cornelius Vanderbilt and expressing thanks to Professor Van Amringe, who was acting president during his absence as a delegate to the International Conference of Peace, gives a clear and interesting account of the progress and present condition of Columbia University.

The cost of the new buildings and grounds was in all $6,879,011. By the payment of President Low of $600,000, completing his great gift for the construction of the Library, the debt against the new site is reduced to about $2,975,000. There is also a debt against the College of Physicians and Surgeons amounting to about $86,500. Although Columbia University has gained greatly by its removal in many ways, including a large increase to its funds by gifts for the grounds and buildings, it is evident that the interest, even though a large part of the debt has been refunded at 3 per cent., is a serious burden, and President Low states that the growth of the University is necessarily checked until this incubus is removed. As a matter of fact the University did receive liberal gifts during the year; $73,494 for current uses and $490,417 for endowment. The increase of the library during the year was 25,404 volumes.

The growth of the University, since the beginning of Mr. Low's administration nine years ago, is indicated by the fact that in this period the officers of instruction have increased from 170 to 339. This is not due to the multiplication of subordinate officers as the number of professors and adjunct professors has increased from 41 to 84. The number of students has increased from 1,753 to 2,208 although the growth has been checked by increasing the re-

quirements, as by adding a fourth year to the medical course and by reorganization of the Law School. A further growth is represented by the students of Barnard College and Teachers College, respectively 278 and 297, both established at the beginning of President Low's administration and now under the sphere of influence of Columbia University. If 1,173 extension students are added the total number under the immediate influence of the University is 3,985.

Among the important educational advances of the year may be mentioned the creation of a large number of scholarships in the place of free and reduced tuition, the establishment of a professorship of anthropology and an adjunct professorship of mechanical engineering, and the decision to conduct a summer session in 1900.

SCIENTIFIC NOTES AND NEWS.

WE record with great regret the death of Sir William Dawson, the eminent geologist and author, for twenty-eight years principal of Mc. Gill University. He was born in Nova Scotia in 1820 and died on November 19th.

THE University of Pennsylvania has appointed a committee to arrange with similar committees of other organizations for a memorial in honor of the late Professor Brinton.

THE Washington *Star* states that the orders recently issued in the case of Professor S. J. Brown, U. S. A., have been modified by the Acting Secretary of the Navy, so as to assign him to duty as astronomical director of the Naval Observatory, to take effect December 17th, instead of making him director of the Nautical Almanac, an office attached to that institution, as originally intended.

A COMMITTEE formed at the Dover Meeting of the British Association is making arrangements for an international meeting of scientific men in connection with the Paris Exposition of 1900. Those wishing to assist in this undertaking should address the assistant secretary, Mr. J. R. Marr, 5 Old Queen Street, London, S. W.

THE third annual meeting of the Society for Plant Morphology and Physiology, will be held, in conjunction with the meetings of the American Society of Naturalists and the Affiliated Scientific Societies at New Haven, on Wednesday, Thursday and Friday, December 27–29th.

FREDERIC W. SANDERS, Ph.D. (Chicago), formerly professor in the University of West Virginia, has been elected President and Director of the New Mexico College of Agriculture and Mechanic Arts and Agricultural Experiment Station at Mesilla Park, New Mexico.

DR. W. H. CORFIELD, professor of hygiene and public health in University College, London, has been appointed to the newly created post of consulting sanitary adviser to the British Office of Works.

MR. HORACE PLUNKETT, M.P., has been appointed vice-president of the new department of Agriculture and Technical Education for Ireland.

WE learn from *Nature* that at the recent annual meeting of the Royal Academy of Medicine in Ireland, the following men of science were elected honorary Fellows of the Academy: Sir J. Burdon-Sanderson, Bart., F.R.S.; Prof. Howard Kelly, Baltimore; Professor Koch, Berlin; Professor Kocher, Bern; Professor Th. Leber, Heidelberg; Sir W. MacCormac, Bart., K.C.V.O., London; Professor Martin, Berlin; Professor Nothnagel, Vienna; Professor Osler, Baltimore; and Sir W. Turner, F.R.S., Edinburgh.

DR. WILLIAM S. CHURCH, President of the Royal College of Physicians, London, has been elected an honorary fellow of University College, Oxford.

THE gold medal of the Highland Agricultural Society of Scotland has been awarded to Professor Cossar Ewart in recognition of his intercrossing and other experiments.

PROFESSOR H. S. CARHART of the Physics Department of the University of Michigan, who, as we have already stated, is in Berlin, has compared the standard Clark cell with the standard of the Physical Technical Institute and found that the electromotive force of the standard Clark cell does not differ more than one in twenty thousand from the average electromotive force of the standard cell of the institute.

Dr. O. von der Heyde, assessor of forestry, in the German Empire, who has been examining the management of forests in India and Japan, is at present in the United States.

We regret to learn that Professor Ernst Mach of the University of Vienna is prevented by illness from giving his lectures this winter.

Dr. Walter J. Hoffman died at Reading, Pa., on November 8th, at the age of fifty-three years. When a surgeon in the U. S. Army he made studies on the North American Indians, and later when connected with the American Bureau of Ethnology published numerous important researches on the subject.

Dr. W. C. Arnison, professor of surgery in the University of Durham, died on November 4th, aged 62 years. He was formerly lecturer in botany and vegetable physiology. He had been president of the section of surgery of the British Medical Association, and was the author of numerous contributions to the medical press.

The death is announced, at the age of 96 years, of Dr. Gonzalo Aróstegui, at one time professor of surgery in the University of Havana.

A memorial of Dr. Müller, who it will be remembered fell a victim to the plague in Vienna on October 23, 1898, was recently unveiled in the quadrangle of the General Hospital of that city. Professor Nothnagel delivered an address.

We learn from *Natural Science* that Dr. Kishinouye and other Japanese zoologists have hired a two-storied building on the shores of the Inland Sea, with the view of converting it into a biological station. Professor J. Ijima has returned from a zoological expedition to Formosa.

Mr. Andrew Carnegie has offered to give $125,000 for a building for the Polytechnic Library Society, of Louisville, Ky., for the construction of a building, provided that the city appropriates at least $10,000 a year for running expenses. He has also offered $50,000 to establish a public library at Houston, Tex., on condition that the city appropriate $4,000 for maintenance.

The Council of the Senate of Cambridge University, having regard to the extensive and valuable collections procured for the University by the Torres Straits Expedition, propose that a further grant of 100*l*. (making 550*l*. in all) be made from the Worts Travelling Scholars' Fund to Dr. A. C. Haddon towards the expenses of the expedition.

Reuter's agency reports that, according to advices received in London, Dr. Donaldson Smith, who left England for East Africa some time ago, has safely arrived at Hargeisa, in Somaliland, with his Somali escort. Dr. Smith, who is accompanied by Mr. Carlisle Fraser, states that it is his intention to push on to Lake Rudolph as quickly as possible and then explore the unknown country to the west. It is, therefore, unlikely that anything more will be heard of the expedition for a considerable time.

Dr. Von Höhnel, professor of botany in Polytechnic Institute at Vienna, has returned from an expedition to Brazil with valuable collections.

Natural Science states that the Danish expedition to East Greenland, under the leadership of Lieut. Amdrup, returned to Copenhagen on September 13th. It had investigated and mapped the tract between 65° 50′ and 57° 22′ N. lat., hitherto unvisited by Europeans. At one time it was inhabited by many Esquimaux, all of whom have now perished. A collection of their skulls and other relics was brought home. Botanical, geological, and zoological observations were made, as well as anthropological measurements on living Esquimaux in other parts. Depots were left at 60° 6′ and 67° and 15′ N. lat.

A steamship has been held in quarantine outside New York City containing two cases of bubonic plague. There was also one death on the voyage. The steamship came direct from Santos, Brazil. It is commonly supposed that there is no chance that the bubonic plague will become epidemic under proper sanitary conditions, but its development in widely separated places causes some apprehension.

The St. Petersburg correspondent of the London *Times* telegraphs that rich auriferous deposits have lately been discovered on the

northwestern shore of the sea of Okhotsk, and have been examined by a commission of mining engineers sent by the Imperial Government to Siberia for that purpose. These deposits will be leased to the highest bidders at a public auction to be held on February 27th next, at the Ministry of Agriculture and State Domains. The agents of the Russian Ministry of Finance abroad are authorized to communicate to intending purchasers the conditions of the sale, and all further particulars concerning the lease of the deposits in question.

The department of pharmacognosy of the University of Michigan will hereafter grow its plants for use in research work. This is to guarantee abundance and authenticity of the drugs. Several acres of ground will be secured, and the plants which are to be the subjects of investigation will be cultivated in large quantities. The plan is an outgrowth of the botanical gardens which were established three years ago.

An Ornithological Club, with about fifteen members, has been organized by Mr. W. E. D. Scott, at Princeton University.

We take the following note from the last issue of *Natural Science:* At a meeting held in The Outlook Tower, Castlehill, Edinburgh, on 14th October, Professor James Geikie, D.C.L., in the chair, an interesting and stimulating address was delivered by Professor Wilbur Jackman, M.A., of Chicago University and Training College, on 'Nature Study, its Methods and Results in School Practice.' Even apart from the able address, which will doubtless be published, the exhibits of notes of work, especially those in water-color, arranged round the room, showed what results await those teachers who have the courage and opportunity to devise courses of nature-study to mitigate the burden of book-work. To many of those present these exhibits and the story of them must have seemed a revelation, but it was interesting to notice that several authorities who took part in the discussion, which lasted for towards two hours after the lecture, reverted to the necessity of 'books.' A guide-book for the teacher may be necessary—not that there is really a lack—but of more books for the scholars there should, in a case like this, be no mention. Owing to the overcrowded audience, an adjournment after the lecture was effected to the Castlehill public shool, where, under the chairmanship of Professor Crum Brown, F.R.S., an interesting discussion was held. To this contributions were made by Mr. Robert Smith, B.Sc., of University College, Dundee, who reported on some nature-study classes which he had conducted, by Mr. Robert Blair, Science Inspector, by Mr. Dunn, H.M.I.S., by Professor J. Arthur Thomson of Aberdeen, by Dr. Maurice Paterson of the Free Church Training College, by Miss Stevenson of the Edinburgh School Board, by Mr. Walter Blaikie, Professor Geddes of Dundee, and others. There was also an exhibition of maps of a botanical survey of Scotland by Mr. Robert Smith, of a cosmosphere by Mr. Walter Blaikie, of a first panel of a proposed spheric atlas by Professor E. Reclus of Brussels, of relief models by Mr. George Guyou, etc. Altogether the meeting was one of considerable educational importance in connection with the teaching of natural science in schools.

According to *Nature* the Society of Arts of London planned to open its new session on November 15th, with an address from the chairman of the Council, Sir John Wolfe Barry, K.C.B., F.R.S., in which it was expected that he would develop the subject of his address last year, 'London Communications,' and would make some suggestions as to the practical means of carrying his proposals into effect. The first paper after the opening meeting will be by Mr. D. E. Hutchins, who will draw attention to the want in England of measures for the proper conservation of woods and forests. At the next meeting Mr. Allan Wyon will give a paper, principally of an antiquarian nature, on the Great Seals of England. At the other meetings before Christmas it is probable that Mr. Joseph Cash will describe the substitutes which have recently been introduced to replace silk, and the methods of their production. Mr. F. G. Aflalo will draw attention to the necessity for some legislation to restrict sea anglers from catching immature and undersized fish; and Mr. H. Bloomfield Bare will describe and illustrate the methods, which have recently achieved considerable success in

America, of teaching drawing by the use of the blackboard, both hands being employed. Mr. H. H. Cunynghame, who has devoted a great deal of attention to the subject, will give a course of Cantor Lectures before Christmas on the art of enamelling. It is intended to demonstrate practically the whole process ef enamel-making during the course. The Juvenile Lectures will be by Mr. Herbert Jackson, of King's College, who will lecture on phosphorescence.

UNIVERSITY AND EDUCATIONAL NEWS.

The San Francisco *Call* says it is understood that the money, amounting to $11,400,000, obtained by Mrs. Jane Stanford for her 285,000 shares of Southern Pacific stock, which she sold recently, will at once be made available for the use of the Stanford University. The Library, the gift of T. W. Stanford, and the Assembly Hall, are now ready for occupancy.

William H. Webb founder of Webb Academy and Home for Shipbuilders, New York city, has by his will left to the Academy the reversion of the larger part of his estate valued at over $600,000. He has also left directly to the Academy his paintings, drawings, books, etc., relating to shipbuilding.

Mr. James Jennings McComb of New York, one of the founders of the Southwestern Presbyterian University at Clarksville, Tenn., has given $70,000 to the endowment fund, making his contributions amount in all to $100,000.

Brown University has received an unconditional gift of ten thousand dollars from the heirs of the late Lucian Sharpe.

The Rev. John Pike has left the reversion of half his property to found two scholarships in Bowdoin College.

It is announced that architects' plans are now being considered by the corporation of Yale University for the memorial building which it is planned to erect before the bi-centennial exercises in 1901. The building will contain a dining hall and an auditorium, and will cost $750,000, of which sum over $400,000 has been subscribed. The building will be at the corner of Grove and College Streets.

The Wilmerding School of Industrial Arts, which the regents of the University of California have established in accord with the will of the late J. C. Wilmerding, will be opened for instruction on January 8, 1900.

A plan submitted by Professor Hanus of Harvard University, to the Cambridge School Board, according to which a certain number of Harvard students should be allowed to undertake practice teaching in the public schools, and teachers should have the privilege of taking courses at Harvard, has been rejected by the board.

The courses of lectures in the sciences at Oxford University for the present term number 41, distributed as follows: physics 6, chemistry 10, geology 3, mineralogy 3, zoology 7, physiology 10, botany 1, anthropology 1. As these courses include both elementary and advanced work, and many of them are only one hour a week, it is evident that Oxford does not compare favorably with the scientific work of other great universities.

The Archæological Institute of America offers six fellowships for next year. Three for work to be done at Athens and three at Rome. Further information can be obtained from Dr. C. H. Young, Secretary, Columbia University.

Mrs. Elizabeth Cary Agassiz has resigned the presidency of Radcliffe College, but has consented to accept the position of honorary president.

Dr. H. S. Leake has been appointed instructor in anatomy in Williams College, to take the place of the late Professor Woodbridge. Dr. Leake is a graduate of Williams College and of the College of Physicians and Surgeons, New York City.

In accordance with the new law permitting French universities to establish professorships for which the means are at hand, two new professorships have been established under the faculty of sciences at the Sorbonne, a chair of histology, to which M. Chatin has been assigned, and a second chair of physics, to which M. Pellat has been assigned. The chair of chemistry, vacant by the death of M. Friedel, has not been filled, but M. Chabrié is giving the courses.

SCIENCE

FRIDAY, DECEMBER 1, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

I.

THE third conference of Astronomers and Astrophysicists was held at the Yerkes Observatory, in Williams Bay, Wisconsin, on September 6, 7 and 8, 1899, in accordance with arrangements made by a committee appointed at the second conference, held at Harvard College Observatory in August of last year. This committee, consisting of Professors Newcomb, Pickering, Morley, Comstock and Hale, had also been authorized to prepare a constitution and arrange for the organization of a permanent society. At the second session of the conference the constitution was adopted, substantially as presented by the committee, and at the last session, on September 8th, the organization was completed with the election of the following officers:

President, Simon Newcomb; Vice-Presidents, C. A. Young, G. E. Hale; Secretary, G. C. Comstock; Treasurer, C. L. Doolittle; Councilors, for two years, E. C. Pickering, J. E. Keeler; Councilors, for one year, E. W. Morley, Ormond Stone.

The undersigned will temporarily act as Secretary.

At a subsequent meeting of the Council by-laws were adopted. It was further voted that a report of the proceedings should be furnished for publication in SCIENCE, to-

gether with abstracts of the papers, prepared by the authors and edited by the Secretary. It is not intended that the Society shall maintain a library, and an exchange of publications with other societies is not expected. The assessment for the current year was set at two dollars. The Secretary was authorized to arrange for a meeting of the Society in New York City in connection with the meeting of the American Association for the Advancement of Science. The charter members number one hundred and fourteen, consisting of those attending the second or third conference who signed a statement of desire that a society be formed and of those who otherwise expressed to the committee or Council their wish to join when the society should be organized.

The constitution and by-laws follow :

CONSTITUTION.

ARTICLE I.—*Name and Purpose.*

1. This association shall be called The Astronomical and Astrophysical Society of America.

2. The purpose of this Society is the advancement of astronomy, astrophysics, and related branches of physics.

ARTICLE II.—*Membership.*

1. Those persons whose names were signed on or before September 15, 1899, to the annexed statement of desire to form such an association shall constitute the charter members of this Society. Other persons may be elected to membership in the Society by the Council hereinafter provided.

2. The Council shall prepare and publish in the form of a by-law uniform rules for the government of such elections.

ARTICLE III.—*Officers.*

1. The officers of the Society shall consist of a president, two vice-presidents, a secretary, and a treasurer, who, in addition to the duties specifically assigned them by this constitution, shall discharge such other duties as are usually incident to their respective offices. These officers, together with four other members of the Society, shall constitute a Council to which shall be entrusted the management of all affairs of the Society not otherwise provided for. The president and secretary of the Society shall serve respectively as chairman and secretary of the Council, and every officer of the Society shall be responsible to the Council and shall administer his office in accordance with its instructions.

2. The Council shall enact such by-laws as may be found needful and proper for administering the affairs of the Society, and may from time to time modify or repeal such by-laws.

3. The president, the vice-presidents and the treasurer shall be elected annually in a manner to be prescribed by the Council, and shall serve until their successors are duly elected and qualified. Two members of the Council shall be chosen at the first annual meeting of the Society to serve for a period of one year, and two members shall be chosen annually to serve for a period of two years or until their successors are duly elected and qualified. The term of office of the secretary shall be three years or until his successor is duly elected and qualified.

ARTICLE IV.—*Meetings.*

1. The Council shall determine the time and place of each meeting of the Society and shall provide for an annual meeting, at which officers shall be elected.

2. The Council shall have charge of the programme for each meeting.

3. At meetings of the Society, regularly called, twenty members shall constitute a quorum.

ARTICLE V.—*Finance.*

1. The Council shall levy an annual assessment upon the members of the Society sufficient to provide the funds required by the Society for the ensuing year; provided that this assessment shall not exceed the sum of five dollars per member in any year.

2. If at any time there shall be required for the purposes of the Society a larger sum than can be obtained in accordance with Section 1 of this article, the Council shall present at an annual meeting of the Society a statement of such need and of the circumstances attending it, and the Society shall thereupon determine by ballot a policy to be adopted in the matter.

3. No officer of the Society shall receive any compensation for services rendered to it, but the Council may by resolution direct the treasurer to reimburse to any officer expenses necessarily incurred by him in the discharge of his official duty.

ARTICLE VI.—*Amendments.*

1. This constitution may be amended by the affirmative votes of three-fourths of the members present at any annual meeting of the Society, but no amendment shall be voted upon unless a notice setting forth the nature of such proposed amendment shall have

been forwarded to the several members of the Society at least one month before the meeting at which it is proposed to be voted upon.

2. It shall be the duty of the secretary to forward such notices of a proposed amendment to this constitution, when so requested in writing by ten members of the Society.

BY-LAWS.

1.—*Election of Members.*

Any person deemed capable of preparing an acceptable paper upon some subject of astronomy, astrophysics, or related branch of physics, may be elected by the Council to membership in the Society upon nomination by two or more members of the Society. At least once in each year the Council shall consider all such nominations and may request the opinion of persons not members of the Council with reference to the qualifications of the nominees. Blanks for such nominations to membership shall be furnished by the secretary.

2.—*Election of Officers.*

The Council shall provide for holding upon the day preceding the last day of each annual meeting a nominating ballot at which each member of the Society may deposit his ballot for each officer to be elected for the ensuing year. Members not in attendance at such annual meeting may send to the secretary their ballots enclosed in a sealed envelope bearing the signature of the voter. The vice-presidents, or in their absence, tellers appointed by the chair, shall canvass the ballots thus cast, and shall prepare and present to the Society a list showing the three persons who have received the largest number of votes for each office to be filled. In case of a plurality of names receiving the same number of votes in third place, all the names in such plurality shall be included in the list.

Upon the last day of each annual meeting written ballots shall be cast by the individual members of the Society for filling each office about to become vacant, of which only those shall be counted which are cast for persons nominated in the lists prepared as above directed for the office in question or for some higher office.

The nominee receiving the greatest number of votes for any office shall be thereby elected and shall be notified of such election in writing, by the secretary, within ten days thereafter. It shall be the duty of each person thus notified to file with the secretary his written acceptance of such office, and if such acceptance is not filed within sixty days after notification the Council by resolution may declare such office vacant and may elect any member of the Society to fill it until the close of the next annual meeting.

3.—*Treasurer.*

The treasurer of the Society shall keep accounts showing all receipts and expenditures of moneys belonging to the Society, and showing also the indebtedness to the Society of each member thereof, on account of unpaid assessments. These accounts shall be submitted at each annual meeting to an auditing committee, of not less than three members, to be appointed by the Council. The secretary shall be *ex-officio* a member of this committee.

4.—*Secretary.*

The secretary shall be the purchasing officer of the Society and the treasurer shall be the disbursing officer, but the total amount expended by the secretary and treasurer without previous authority from the Council shall not exceed the sum of fifty dollars in any year.

5.—*Unpaid Assessments.*

The treasurer shall report to the Council at each annual meeting a list of all members indebted to the Society on account of unpaid assessments.

6.—*Order of Business.*

The following order of business is prescribed for meetings of the Council:

a. Call to order by the chair.
b. Reading of minutes of last meeting.
c. Announcements by the chair.
d. Announcements by the secretary.
e. Announcements or reports by other officers.
f. Unfinished business.
g. New business.
h. Miscellaneous.
i. Adjournment.

The conference was attended by about fifty representatives of astronomy and physics. Professor Harkness presided over the sessions.

The following are abstracts of the papers presented, prepared as stated above:

S. J. BROWN: *Position of the Polar Axis and the Flattening of Neptune from the changes in orbit of its Satellite.*

The large changes which had been observed in the longitude of the node and the inclination of the orbit plane of Neptune's satellite referred to the earth's equator were explained by Tisserand on the as-

sumption of only a moderate polar compression of the planet. The orbits based upon the measures of Professors Newcomb, Hall, Holden, Hermann Struve and A. Hall, Jr., were best satisfied by a uniform, progressive change of the above elements. From a series of observations by Barnard in 1897–98, and another by himself, the author has been enabled to show that there is a variation in the rate of this change. The result of a least square solution from all the available elements from 1848 to 1898 was given in a table. Although the residuals are but slightly smaller than would result from the assumption of a uniform rate, this is chiefly due to the inaccuracy of the earlier elements. The validity of a variable rate is further confirmed by an apparent increase in the mean motion of the satellite referred to the movable node of the orbit plane on the Earth's equator, which is otherwise difficult to explain. The equatorial protuberance of the planet will cause the pole of the satellite's orbit to describe, with uniform retrograde motion, a small circle around the pole of the planet's equator considered as a fixed point, while the inclination of the two planes will remain constant. The node of the satellite's orbit on the planet's equator will thus move uniformly along the latter, in a direction contrary to the motion of the satellite. The differential equations of this motion were given.

A least square solution of 36 equations of condition gave the following elements of the planet's equator:

$$\left.\begin{array}{ll} \gamma & 17^\circ.84 \\ I_0 & 49^\circ.38 \\ \theta_0 & 119^\circ.16 \\ N_0 & 22^\circ.02 \\ \Delta\theta & 0^\circ.677 \end{array}\right\} \text{Equator of 1850.0}$$

The flattening is $\varepsilon = \frac{1}{102.2}$.

The period of the revolution of the pole of the satellite's orbit is 531.75 years. The flattening is a quantity represented by a difference of only 0″.03 between the polar and equatorial diameters of the planet—a quantity scarcely measurable in the most powerful telescope.

(To be published in the *Astronomical Journal.*)

A. S. FLINT: *The Repsold Transit Micrometer of the Washburn Observatory and Slat Screen Apparatus.*

The transit micrometer is at present employed on the meridian circle, of 12.2 cm. aperture, in a new series of observations for stellar parallaxes by the method of meridian transits. The essential feature of the instrument is an auxiliary screw which is geared with the regular right ascension screw and carries the eye-piece to follow the movable thread. The observer keeps a star image bisected continuously by means of two turning heads on this auxiliary screw, one on each side of the micrometer box, while a series of contact points on the head of the right ascension screw effect the electric signals on the chronograph. The present observer finds the probable error of a single signal to be 0.030s., the same as in the ordinary method with fixed threads.

This micrometer has also a device for obtaining a record of several bisections on a given star in declination without the necessity of reading the micrometer head. A lever clamped to the declination screw travels over a short graduated arc and, being pressed down by the observer, pricks a mark on a strip of paper.

Some suggestions were made for minor improvements, but the performance of the micrometer as a whole has been found very satisfactory.

The slat screen apparatus, designed by Professor Comstock, is intended to furnish the simplest means of diminishing the apparent magnitude of brighter stars. A frame

clamped to the objective end of the telescope bears a series of five slats, each 25 mm. wide, in front of the objective. These slats rotate about their longitudinal axes and are so connected as to turn together by means of a wire cord passing over a pulley near the eye end of the telescope. The entire attachment at the objective end is made of aluminium, and the total weight added to the telescope is 27 oz. (0.76 kg.). As viewed with the slats partly turned, a bright star appears as a central stellar image with a line of spectral images extending on either side at right angles to the direction of the slats. Comparisons indicate that this novel appearance has no influence upon the probable error of a single chronographic signal.

E. E. BARNARD: *Triangulation of Star Clusters.*

From the advantages given by the great scale of the 40-inch, it was decided to measure the positions of a number of stars in some of the globular clusters, as a basis for the study of their motions in the future. For this purpose the clusters M 3, M 5, M 13, M 15 and M 92 were selected as representative.

In comparison with Scheiner's photographic measures of M 13 it was found that several of the stars had either diminished very greatly in brightness of late years, or that their light must come mostly from the blue end of the spectrum. The stars, 382 and 393, of his list, are striking examples. Both these stars are given by him as 12.7 magnitude. Visually, the first, which is his normal star, cannot be brighter than the 15th magnitude, while the second is at the limit of the great telescope and has been seen a few times only. Though it is possible that these stars may be variable, the observations do not seem to show it, except possibly in the case of No. 393.

Variable Stars in Clusters.

Some of the small variable stars discovered by Professor Bailey have been regularly observed during the measures of that cluster. Besides the small variables there are three rather bright stars in this cluster which are also variable. Two of these were discovered eight or ten years ago by Mr. C. D. Packer, of London. These three stars vary slowly, requiring upwards of a month for their variations, and one of them has a much longer period. The small stars, however, are very rapid in their changes, with nearly the same periods, averaging, as Professor Bailey has shown, about half a day. Variable No. 33, which rises from the 15th to about the 14th magnitude, and whose period is 12 hours 1 minute, has been specially observed at the request of Professor Bailey. The observations show that this object lies dormant for a large portion of its period as a faint star of the 15th magnitude. It suddenly begins to brighten, and in about 15 minutes has doubled its light; it then slowly declines to a position of rest.

Several new variables were found in this cluster that are not marked on the Harvard photographs.

The Fifth Satellite of Jupiter.

The fifth Satellite of Jupiter was observed with the 40-inch, both in 1898 and 1899, and good measures obtained of it. From the elongation distances obtained at these observations, a new value for the motion of the line of apsides of the orbit was determined. This was found to amount to 900° a year, or a complete revolution of the orbit in 4.9 months. With this value of the motion of the perijove, all the elongation distances observed for the past seven years were accurately represented. A new determination was also made of the periodic time which is 11 h. 57 m. 22. 647 s. As this period was derived from nearly five

thousand revolutions it is probably very accurate.

The Annular Nebula in Lyra.

A number of the Planetary Nebulæ have been observed and measured. The position of the nucleus of the annular Nebula of Lyra (M 57) was carefully measured in 1898 and 1899. These, compared with Mr. Burnham's measures in 1891 with the 36-inch of the Lick Observatory, seem to show a sensible proper motion for the whole of about $0''.13$ annually. This can be verified with certainty by measures four or five years hence.

The small stars near this nebula measured by Professor Hall at Washington in 1877, have been remeasured and the observations show that one of these stars (*f* of Hall's list) of the 15th magnitude seems to have a considerable proper motion.

Difference of Declination of Atlas and Pleione.

The summers and winters of Williams Bay subject the 40-inch to extreme ranges of temperature. Micrometer measures were made in all temperatures between $+80°$ F. and $-26°$ F. These observations showed that the focus of the great objective changed to the extent of about 0.7 inch—shortening with the cold weather. To test these changes, a great number of measures of the difference of declination of Atlas and Pleione of the Pleiades, had been made in 1897, 1898 and 1899. These measures besides showing considerable temperature changes, also show some peculiarities not satisfactorily accounted for and which do not show in similar measures of Electra and Caeleno, and which could be explained by a slight oscillation in the position of one of the stars. It is intended to further continue these measures.

ORMOND STONE: *On the Motion of Hyperion.*

If, in the first approximation the motion of the perisaturnium of Hyperion be assumed to be $4n'-3n$, in which n and n' are the instantaneous mean motions in longitude of Titan and Hyperion, the perturbative function will contain an expression of the form

$$C_1\,\{e_0 + e'\,[1+\cos(4l'-3l-\pi')]\}, \quad (1)$$

in which C_1 is a function of the mass of Titan and the mean distances from Saturn of Titan and Hyperion, e_0 is the quasi-eccentricity of the orbit of Hyperion introduced by the erroneous assumption in regard to the mean motion of the perisaturnium, e' and π' are the eccentricity and longitude of perisaturnium properly so-called, and l' and l are the longitudes in orbit of Hyperion and Titan, the motions of the two bodies being considered co-planar.

Integration, assuming the values of the coefficients given by Newcomb in his 'Astronomical Papers,' Vol. III., and comparison with Eichelberger's value of the inequality in mean longitude detected by Hermann Struve, result in two solutions, giving rise to two sets of values for m, the mass of Titan, and e':

$$m = \frac{1}{5000}, \qquad e' = 0.0224;$$
$$m = \frac{1}{4370}, \qquad e' = 0.0195.$$

As neither of these values of m differs greatly from the more reliable values found hitherto, it is uncertain which of the solutions is the correct one, and we can only say, at present, that the true value of the eccentricity of the orbit of Hyperion probably does not differ greatly from 0.02.

W. W. CAMPBELL: *The Variable Velocity of Polaris in the Line of Sight.*

Polaris furnishes an interesting case of variable velocity in the line of sight. Six spectrograms were obtained in 1896, as follows:

Gr. M. T. 1896, Sept.	8^d 22.8^h	—20.1 km.
"	15 22.8	—19.1
"	23 21.4	—18.9
Oct.	5 21.0	—19.0
Nov.	11 19.3	—20.1
Dec.	8 16.7	—20.3
	Mean	—19.6

The agreement of these results was satisfactory, and gave no evidence of variable velocity.

In order to test the current results of our work, another photograph of the spectrum of Polaris was obtained on Aug. 8, 1899. This yielded a velocity of —13.1 km., and led to the suspicion that we were dealing with a variable. Two additional plates were secured on August 9th and 14th, which yielded velocities of —11.4 and —9.0 km., respectively. Inasmuch as a range of 4 km. is not permissible in the case of such an excellent spectrum, the star was suspected to be a short period variable, and further observations were obtained, as below :

Gr. M. T. 1899	Velocity	Measured by
August 9^d 0.8^h	—13.1	Campbell
9 20.1	—11.4	Campbell
14 22.8	— 9.0	Campbell
16 0.1	—14.1	Campbell
23 0.3	—10.9	Campbell
24 0.8	—15.2	Campbell
26 0.9	— 9.4	Campbell
*	— 8.6	Wright
27 0.3	—10.6	Campbell
27 16.2	—14.0	Campbell
28 0.8	—14.7	Campbell
*	—14.3	Wright
28 16.3	—13.7	Wright
29 0.4	—12.1	Wright
29 18.8	— 9.6	Wright
30 0.0	— 8.9	Wright
30 16.2	— 9.3	Wright

* Measures of the same plate by Mr. Wright.

On plotting these observations it became evident that Polaris is a spectroscopic binary, having a period a little less than four days. The 1899 observations have been collected and plotted on the assumption that the period is 3^d 23^h. The velocity, at present, seems to be included between —8.6 and —14.6 km., having an extreme range of only 6 km. The velocity of the binary system seems to be about 12 km.

The determinations of velocity made in 1896 lie entirely outside of the present range of values, and leave no doubt that the velocity of the binary system is changing under the influence of an additional disturbing force. I think it is certain, therefore, that Polaris is at least a triple system.

The 1896 observations were made at intervals differing but little from multiples of the period of the binary system, and therefore fell near the same point in the velocity curve. Assuming a period of 3^d 23^h ±, there is no difficulty in selecting the epoch of minimum so that these six observations will fall on the curve satisfying the 1899 observations. The residuals will be negligible if we assume the observations to fall near the lower part of the curve ; and I have no doubt that future determinations of the orbit will definitely place them there. It will be seen that the velocities of the binary system in 1896 and in 1899 differ about 6 km.

The Spectroscopic Binary Capella.

An examination of six spectrum plates of *a Aurigæ*, obtained with the Mills' Spectrograph in 1896–7, leaves no doubt that this star is a spectroscopic binary. The spectrum is composite. The component whose spectrum is of the solar type furnished the following velocities with reference to the solar system :

1896, Aug.	31	+ 34 km.
Sept.	16	+ 54
Oct.	3	+ 49
Oct.	5	+ 44
Nov.	12	+ 4
1897, Feb.	24	+ 3

On the first photograph the spectrum is of essentially normal solar type; on the

others it is unmistakably different. There appears to be a second component whose spectrum contains the $H\gamma$ line and the rather prominent iron lines. On the plates of September 16th, October 3d and October 5th, these lines are shifted toward the violet with reference to the solar type spectrum; and in the spectra of November 12th, and February 24th they are shifted toward the red. (Papers published in *Astrophysical Journal.*)

KURT LAVES: *On the Determination of the Constant of Nutation from Heliometer Observations of Eros.*

The opposition of Eros at the end of next year will grant very valuable material for the determination of N, the constant of nutation. In No. 3,156 of the *A. N.*, I have pointed out that this constant could be well determined from heliometer observations of such small planets as come nearer to the earth than the astronomical unit. In the discussion of the heliometer observations of Victoria, made for the purpose of deriving a reliable value of the mean solar parallax, Dr. Gill has carried out this plan. He has found $N = 9''.2068 \pm 0''.0034$ (see Annals of the Cape of Good Hope, Vol. VI., part 6). This result agrees excellently with the value of N derived from direct observations. The reason for this agreement is due to Dr. Gill's new value derived for L, the constant of lunar equation. Indeed, in a former attempt to obtain N by this method, I had employed Leverrier's value $L = 6''.50$, and I was led to a value of $N = 9''.26$. The classical work of Dr. Gill has shown, beyond doubt, that the correct value of L is much smaller; Dr. Gill gives for it $6''.414 \pm 0''.009$. With this value he has obtained the result mentioned above. The quantities on which the final determination of N depends are: the constant of luni-solar precession p^0, the mean solar parallax π^0, the constant of lunar equation L, and the inclination of the moon's orbit to the ecliptic c. We find

$$dN = 0.45\,dL - 0.34\,d\pi^0 + 0.17\,dp^0 + 0.002\,dc.$$

It is thus evident that the small probable error of L in Dr. Gill's value has mainly reduced the formerly large probable error of N. We may regard that the probable errors of L, π^0, p^0, c are as follows:

$$\Delta L = \pm 0''.009\,; \quad \Delta\pi^0 = 0''.005\,; \quad \Delta p^0 = 0''.004\,; \quad \Delta c = 1''.$$

ΔL and $\Delta\pi^0$ are the values obtained from the heliometer observations of Victoria. The smallest geocentric distance of this small planet was 0.82. The greatest geocentric displacement observable for the purpose of determining L was $15''$ (this displacement is due to the semi-monthly translatory motion of the Earth's center about the center of gravity of the System Earth-Moon).

During the next opposition of Eros this planet will be at a mean geocentric distance of 0.34 for about eight weeks, the displacement witnessed will amount to about $37''$. From this it is evident that a systematic series of heliometer observations of this interesting object, will both give us a much more accurate value of π^0 and grant an excellent redetermination of L. It is found that the magnitude of Eros will vary between 8.8 and 9.7 during this time. The most favorable opposition possible for Eros will reduce the geocentric distance to 0.15. Assuming the mean distance for two weeks to be 0.20 we shall have an angle of nearly $64''$ available for heliometric measurements.

Inner Potential Forces in Astronomy.

In No. 445 of the *Astronomical Journal* an investigation was published concerning the

ten integrals of the problem of n bodies for forces involving the coördinates and their first and second differential quotients. The conclusion was reached that the new potential function W must be an arbitrary function of the mutual distances and relative velocities of the n bodies and must not contain the time explicitly, in order that the ten integrals should hold. In a communication to the Academy of Sciences of Leipzig on Jan. 9, 1899, Professor A. Mayer, of Leipzig University, has recently taken up the same problem. His investigation deals with the problem in a more general way and has brought to light an oversight of mine in the above definition of W. Following this W should, in addition to the arguments mentioned above, contain the differential quotients of the mutual distances. It is my intention to give a detailed account of Professor Mayer's paper in one of the next issues of the *Astronomical Journal.*

A. HALL, JR.: *The Aberration Constant from Meridian Zenith Distances of Polaris.*

A series of measures was begun by the author with the meridian circle of the Detroit observatory of meridian zenith distances of Polaris, with the idea of determining the aberration constant and the latitude variation.

Measures were made above and below the pole, direct and reflected, but the number of reflected observations has been rather small. A rough reduction of the observations made between May 1898, and July 1899, gives the following values for the aberration constant:

	Direct.	Reflected.
Upper culmination	20″.60	20″.66
Lower culmination	20 .58	20 .40

M. B. SNYDER: *The Phonochronograph, and its Advantages in Certain Astronomical Observations.*

In all kinds of astronomical observations, where phenomena, especially of an unpredicted character, rapidly succeed each other, it has invariably been found extremely difficult to make time records that can subsequently and with certainty be identified with the phenomena. Even with tried assistants as recorders, and with a prearranged code of chronographic signals there is usually a double failure; first, the proper records are not made by the assistants, and secondly, the time signals can not be satisfactorily identified.

The phonochronograph, as for brevity I designate a high grade phonograph also transformed into an efficient chronograph, seems fully to obviate the difficulties mentioned. The instrument records any vocal expression made by the observer along with a simultaneous sound automatically produced every second or two by the clock or chronometer. The record both for time, and for character of phenomena, is unbiased, absolutely identifiable, and can be read off without introducing any reaction time, excepting that originally entering.

The instrument consists of a phonograph whose cylinder rotates uniformly, and whose sliding carriage, which by turns bears both the recorder and the receiver, also has attached, near a second mouthpiece, a small electromagnet whose armature is attached to a light wooden hammer, which at each closure of the electrical circuit by the clock, strikes a small resonating box placed opposite the second mouthpiece. With properly selected resonating box, it is found that not only can the time signal always be read off by ear as distinct from the vocal record, but be visually distinguished as well. For the purpose of reading off the time record, so as not again to interpolate a reaction time, the sliding carriage also bears a microscope of moderate power, which is placed at an angle of about 90 degrees back of the recording diaphragm and

enables one clearly to distinguish the clock from the vocal records. To enable the angular distance between the clock record and any given vocal record to be read off, a graduated circle, with stationary index, is attached to the end of the phonographic cylinder. The instrument is also provided with a rotameter, which rests on the surface of the cylinder and indicates the linear, instead of the angular, distance between records.

With present chronographic appliances it is feasible to construct a phonochronograph that will run for ten minutes, and it seems mechanically possible to treble this at least.

In observations of the meteors, where unexpected features occur, and particularly in solar eclipses, the phonochronograph seems to possess peculiar advantages. It is also suggested that the usual seconds-counting done by an assistant during totality can be done, without any special sacrifice or nervousness, by a phonographic cylinder previously prepared.

G. W. Hough: *Actinism of Moonlight in a Total Eclipse.*

Near the middle of the total eclipse of the moon, on December 27, 1898, two negatives were made with the finder telescope, on a Seed 27 plate, with an exposure of five minutes each.

The resulting negatives gave good printing density.

Near the end of totality it clouded, but on the following night a number of negatives were made with the same telescope with reduced apertures.

It was found that an aperture of 0.16 inch, and an exposure of ten seconds gave a negative similar to that made during the eclipse.

From these experiments the actinism or photographic power of the eclipsed moon was found to be $\frac{1}{17000}$ that of the uneclipsed moon. The eclipsed moon was not equally luminous, and the photographic power might range between $\frac{1}{17000}$ and $\frac{1}{30000}$.

Young's General Astronomy gives the photographic power of the eclipsed moon of January 28, 1888, as determined by Professor Pickering, as $\frac{1}{1400000}$ that of the uneclipsed moon.

I had intended to determine definitely, with my sensitometer, the total actinism of the eclipsed moon, but the exposures which were made for me by a student in astronomy were all too short to be of use.

In 1892 I published a table giving the relative sensitiveness of a considerable number of commercial dry plates for sunlight, candle light, and through red glass. For the rapid plates it was found that the color-sensitized plates were twice as sensitive in the yellow and eight times as sensitive in the red as the ordinary plates.

As the light of the eclipsed moon is always colored, it is obvious that its actinism or photographic power will depend on the kind of plate employed; and possibly on its manipulation previous to development, owing to the effect of preliminary or supplementary exposure.

George E. Hale: *Carbon in the Chromosphere.*

The level at which carbon vapor exists in the atmosphere of the sun was definitely ascertained in 1897 with the 40-inch Yerkes telescope, when the green carbon (or hydrocarbon) fluting was found in the spectrum of the chromosphere. The layer of carbon vapor to which the fluting is due is not more than a second of arc in thickness, and lies in immediate contact with the photosphere. For this reason it can be observed only with the most powerful telescopes, used under the most perfect atmospheric conditions. The fluting has been repeatedly seen at the Yerkes Observatory during the past summer, and its individual lines identified

with the dark lines in the solar spectrum ascribed by Rowland to carbon. On August 17th the yellow carbon fluting, which is more difficult than the green fluting, was also found. These observations reveal an interesting similarity of the sun to red stars of Secchi's fourth type, in which a dense absorbing atmosphere of carbon (which is far more conspicuous than in the sun) has recently been found with the 40-inch telescope to be surmounted by an atmosphere giving a spectrum of bright lines.

Some New Forms of Spectroheliographs.

Of the various forms of spectroheliographs described in my previous papers, the simplest and best is undoubtedly that in which the instrument is moved as a whole at right angles to the axis of the telescope, the solar image and photographic plate remaining stationary. It is not always possible, however, to employ a spectroheliograph of this form. With the forty-inch telescope, for example, the motion of the very heavy spectroheliograph required could not be accomplished without jarring the instrument. For this reason it has been decided to cause the solar image to move across the first slit by means of the slow motion declination motor. The first and second slits are fixed with reference to each other, and the photographic plate is moved across the second slit by means of a screw driven by the same motor, which is mounted on the tube of the forty-inch telescope. A wide range of exposures can be secured by means of a system of change gears. This spectroheliograph, which has an aperture of $6\frac{1}{4}$ inches, is now nearly ready for trial.

Two other forms of spectroheliographs may occasionally prove useful. The solar image is moved across the first slit in the one case by means of a photographic doublet, of large field, mounted between the slit and the principal focal plane of the image lens, and in the second case by means of a right angle prism, placed immediately in front of the first slit, with hypothenuse face parallel to the optical axis of the collimator. A suitable combination of mirrors may be used instead of the prism. The doublet or prism are connected with a carriage bearing the photographic plate across the second slit, and are moved in a direction at right angles to the optical axis of the collimator. Either device, used in conjunction with a heliostat, affords an easy means of transforming a large fixed laboratory spectroscope, of almost any type, into a spectroheliograph.

Comparison of Stellar Spectra of the Third and Fourth Types.

As previous observations of the faint red stars of Secchi's fourth type have shown none of the lines in their spectra it has been impossible to effect any satisfactory comparison of these stars with the red stars of the third type. So far as their characteristic features go, the spectra are quite dissimilar, the pronounced carbon absorption bands of the fourth type having no counterpart in the banded spectra of the third type stars. The photographs of these spectra recently obtained with the forty-inch telescope, by Mr. Ellerman and the writer, contain hundreds of lines, and render comparisons possible. From these plates it has been found that in certain limited regions third and fourth type spectra are almost identical. It is, therefore, probable that the stars of these two great classes are closely related to each other and to stars like the Sun. The study of fourth type stars is being continued at the Yerkes Observatory.

(To be continued.)

EDWIN B. FROST,
Acting Secretary.

YERKES OBSERVATORY,
WILLIAMS BAY, WIS.

ADDRESS OF THE PRESIDENT BEFORE THE SECTION OF GEOGRAPHY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

II.

Evolution of the Continental and Oceanic Areas.

I have now pointed out what appear to me to be some of the more general results arrived at in recent years regarding the present condition of the floor of the ocean. I may now be permitted to indicate the possible bearing of these results on opinions as to the origin of some fundamental geographical phenomena; for instance, on the evolution of the protruding continents and sunken ocean-basins. In dealing with such a problem much that is hypothetical must necessarily be introduced, but these speculations are based on ascertained scientific facts.

The well-known American geologist, Dutton, says: "It has been much the habit of geologists to attempt to explain the progressive elevation of plateaus and mountain platforms, and also the folding of strata, by one and the same process. I hold the two processes to be distinct, and having no necessary relation to each other. There are plicated regions which are little or not at all elevated, and there are elevated regions which are not plicated." Speaking of great regional uplifts, he says further: "What the real nature of the uplifting force may be is, to my mind, an entire mystery, but I think we may discern at least one of its attributes, and that is a gradual expansion or diminution of density of the subterranean magmas. * * * We know of no cause which could either add to the mass or diminish the density, yet one of the two must surely have happened. * * * Hence I infer that the cause which elevates the land involves an expansion of the underlying magmas, and the cause which depresses it is a shrinkage of the magmas; the nature of the process is at present a complete mystery." I shall endeavor to show how the detailed study of marine deposits may help to solve the mystery here referred to by Dutton.

The surface of the globe has not always been as we now see it. When, in the past, the surface had a temperature of about 400° F., what is now the water of the ocean must have existed as water vapor in the atmosphere, which would thereby—as well as because of the presence of other substances—be increased in density and volume.

Life, as we know it, could not then exist. Again, science forsees a time when low temperatures, like those produced by Professor Dewar at the Royal Institution, will prevail over the face of the earth. The hydrosphere and atmosphere will then have disappeared within the rocky crust, or the waters of the ocean will have become solid rock, and over their surface will roll an ocean of liquid air about forty feet in depth. Life, as we know it, unless it undergoes suitable secular modifications, will be extinct. Somewhere between these two indefinite points of time in the evolution of our planet it is our privilege to live, to investigate, and to speculate concerning the antecedent and future conditions of things.

When we regard our globe with the mind's eye, it appears at the present time to be formed of concentric spheres, very like, and still very unlike, the successive coats of an onion. Within is situated the vast nucleus or *centrosphere;* surrounding this is what may be called the *tektosphere,** a shell of materials in a state bordering on fusion, upon which rests and creeps the *lithosphere.* Then follow *hydrosphere* and *atmosphere,* with the included *biosphere.*† To the interaction

* τηκτός, molten.

† βιος.

of these six geospheres, through energy derived from internal and external sources, may be referred all the existing superficial phenomena of the planet.

The vast interior of the planetary mass, although not under direct observation, is known, from the results of the astronomer and physicist, to have a mean density of 5.6, or twice that of ordinary surface rock. The substances brought within the reach of observation in veinstones, in lavas, and hypogene rocks—by the action of water as a solvent and sublimant—warrant the belief that the centrosphere is largely made up of metals and metalloids with imprisoned gases. It is admitted that the vast nucleus has a very high temperature, but so enormous is the pressure of the super-incumbent crust that the melting-point of the substances in the interior is believed to be raised to a higher value than the temperature there existing—the centrosphere in consequence remains solid, for it may be assumed that the melting-point of rock-forming materials is raised by increase of pressure. Astronomers from a study of precession and nutation have long been convinced that the centrosphere must be practically solid.

Recent seismological observations indicate the transmission of two types of waves through the earth—the condensational-rarefactional and the purely distortional—and the study of these tremors supports the view that the centrosphere is not only solid, but possesses great uniformity of structure. The seismological investigations of Professors Milne and Knott point also to a fairly abrupt boundary or transition surface, where the solid nucleus passes into the somewhat plastic magma on which the firm upper crust rests.

In this plastic layer or shell—named the *tektosphere*—the materials are most probably in a state of unstable equilibrium and bordering on fusion. Here the loose-textured solids of the external crust are converted into the denser solids of the nucleus or into molten masses, at a critical point of temperature and pressure; deep-seated rocks may in consequence escape through fissures in the lithosphere. Within the lithosphere itself the temperature falls off so rapidly towards the surface as to be everywhere below the melting-point of any substance there under its particular pressure.

Now, as the solid centrosphere is slowly contracted from loss of heat, the primitive lithosphere, in accommodating itself—through changes in the tektosphere—to the shrinking nucleus, would be buckled, warped, and thrown into ridges. That these movements are still going on is shown by the fact that the lithosphere is everywhere and at all times in a slight but measureable state of pulsation. The rigidity of the primitive rocky crust would permit of considerable deformations of the kind here indicated. Indeed, the compression of mountain chains has most probably been brought about in this manner, but the same cannot be said of the elevation of plateaus, of mountain platforms, and of continents.

From many lines of investigation it is concluded, as we have seen, that the centrosphere is homogeneous in structure. Direct observation, on the other hand, shows that the lithosphere is heterogeneous in composition. How has this heterogeneity been brought about? The original crust was almost certainly composed of complex and stable silicates, all the silicon dioxide being in combination with bases. Lord Kelvin has pointed out that, when the solid crust began to form, it would rapidly cool over its whole surface; the precipitation of water would accelerate this process, and there would soon be an approximation to present conditions. As time went on the plastic or critical layer—the tektosphere—immedi-

ately beneath the crust would gradually sink deeper and deeper, while ruptures and readjustments would become less and less frequent than in earlier stages. With the first fall of rain the silicates of the crust would be attacked by water and carbon dioxide, which can at low temperatures displace silicon dioxide from its combinations. The silicates, in consequence, have been continuously robbed of a part, or the whole, of their bases. The silica thus set free goes ultimately to form quartz veins and quartz sand on or about the emerged land, while the bases leached out of the disintegrating rocks are carried out into the ocean and ocean-basins. A continuous disintegration and differentiation of materials of the lithosphere, accompanied by a sort of migration and selection among mineral substances, is thus always in progress. Through the agency of life, carbonate of lime accumulates in one place; through the agency of winds, quartz sand is heaped up in another; through the agency of water, beds of clay, of oxides of iron and of manganese are spread out in other directions.

The contraction of the centrosphere supplies the force which folds and crumples the lithosphere. The combined effect of hydrosphere, atmosphere, and biosphere on the lithosphere gives direction and a determinate mode of action to that force. From the earliest geological times the most resistant dust of the continents has been strewn along the marginal belt of the sea-floor skirting the land. At the present time the deposits over this area contain on the average about 70 per cent. of free and combined silica, mostly in the form of quartz sand. In the abysmal deposits far from land there is an average of only about 30 per cent. of silica, and hardly any of this in the form of quartz sand. Lime, iron, and the other bases largely predominate in these abysmal regions. The continuous loading on the margins of the emerged land by deposits tends by increased pressure to keep the materials of the tektosphere in a solid condition immediately beneath the loaded area. The unloading of emerged land tends by relief of pressure to produce a viscous condition of the tektosphere immediately beneath the denuded surfaces. Under the influence of the continuous shakings, tremors, and tremblings always taking place in the lithosphere the materials of the tektosphere yield to the stresses acting on them, and the deep-seated portions of the terrigenous deposits are slowly carried towards, over, or underneath the emerged land. The rocks subsequently re-formed beneath continental areas out of these terrigenous materials, under great pressure and in hydrothermal conditions, would be more acid than the rocks from which they were originally derived, and it is well known that the acid silicates have a lower specific gravity than the intermediate or basic ones. By a continual repetition of this process the continental protuberances have been gradually built up of lighter materials than the other parts of the lithosphere. The relatively light quartz, which is also the most refractory, the most stable, and the least fusible among rock-forming minerals, plays in all this the principal *rôle*. The average height of the surface of the continents is about three miles above the average level of the abysmal regions. If now we assume the average density of the crust beneath the continents to be 2.5, and of the part beneath the abysmal regions to be 3, then the spheroidal surface of equal pressure—the tektosphere—would have a minimum depth of eighteen miles beneath the continents and fifteen miles beneath the oceans, or if we assume the density of the crust beneath the continents to be 2.5, and beneath the abysmal regions to be 2.8, then the tektosphere would be twenty-eight miles beneath the continents and twenty-

five miles beneath the oceans. The present condition of the earth's crust might be brought about by the disintegration of a quantity of quartz-free volcanic rock, covering the continental areas to a depth of eighteen miles, and the re-formation of rocks out of the disintegrated materials.

When the lighter and more bulky substances have accumulated there has been a relative increase of volume, and in consequence bulging has taken place at the surface over the continental areas. Where the denser materials have been laid down there has been flattening, and in consequence a depression of the abysmal regions of the ocean-basins. It is known that, as a general rule, where large masses of sediment have been deposited, their deposition has been accompanied by a depression of the area. On the other hand, where broad mountain platforms have been subjected to extensive erosion, the loss of altitude by denudation has been made good by a rise of the platform. This points to a movement of matter on to the continental areas.

If this be anything like a true conception of the interactions that are taking place between the various geospheres of which our globe is made up, then we can understand why, in the gradual evolution of the surface features, the average level of the continental plains now stands permanently about three miles above the average level of those plains which form the floor of the deep ocean basins. We may also understand how the defect of mass under the continents and an excess of mass under the oceans have been brought about, as well as deficiency of mass under mountains and excess of mass under plains. Even the local anomalies indicated by the plumb-line, gravity, and magnetic observations may in this way receive a rational explanation. It has been urged that an enormous time—greater even than what is demanded by Darwin—would be necessary for an evolution of the existing surface features on these lines. I do not think so. Indeed, in all that relates to geological time I agree, generally speaking, with the physicists rather than with the biologists and geologists.

Progress of Oceanic Research.

I have now touched on some of the problems and speculations suggested by recent deep-sea explorations; and there are many others, equally attractive, to which no reference has been made. It is abundantly evident that, for the satisfactory explanation of many marine phenomena, further observations and explorations are necessary. Happily there is no sign that the interest in oceanographical work has in any way slackened. On the contrary, the number of scientific men and ships engaged in the study of the ocean is rapidly increasing. Among all civilized peoples and in all quarters of the globe the economic importance of many of the problems that await solution is clearly recognized.

We have every reason to be proud of the work continually carried on by the officers and ships attached to the Hydrographic Department of the British Navy. They have surveyed coasts in all parts of the world for the purposes of navigation, and within the past few years have greatly enlarged our knowledge of the sea-bed and deeper waters over wide stretches of the Pacific and other oceans. The samples of the bottom which are procured, being always carefully preserved by the officers, have enabled very definite notions to be formed as to the geographical and bathymetrical distribution of marine deposits.

The ships belonging to the various British Telegraph Cable Companies have done most excellent work in this as well as in other directions. Even during the present year Mr. R. E. Peake has in the s.s. *Brit-*

annia procured 477 deep soundings in the North Atlantic, besides a large collection of deep-sea deposits, and many deep-sea temperature and current observations.

The French have been extending the valuable work of the *Talisman* and *Travailleur*, while the Prince of Monaco is at the present moment carrying on his oceanic investigations in the Arctic Seas with a large new yacht elaborately and specially fitted out for such work. The Russians have recently been engaged in the scientific exploration of the Black Sea and the Caspian Sea, and a special ship is now employed in the investigation of the Arctic fisheries of the Murman coast under the direction of Professor Knipowitsch. Admiral Makaroff has this summer been hammering his way through Arctic ice, and at the same time carrying on a great variety of systematic observations and experiments on board the *Yermak*—the most powerful and most effective instrument of marine research ever constructed. Mr. Alexander Agassiz has this year recommenced his deep-sea explorations in the Pacific on board the U. S. steamer *Albatross*. He proposes to cross the Pacific in several directions, and to conduct investigations among the Paumotu and other coral island groups. Professor Weber is similarly employed on board a Dutch man-of-war in the East Indian Seas. The Deutsche Seewarte at Hamburg, under the direction of Dr. Neumayer, continues its praiseworthy assistance and encouragement to all investigators of the ocean, and this year the important German Deep-sea Expedition, in the s.s. *Valdivia*, arrived home after most successful oceanographical explorations in the Atlantic, Indian, and Great Southern Oceans.

The *Belgica* has returned to Europe safely with a wealth of geological and biological collections and physical observations, after spending, for the first time on record, a whole winter among the icefields and icebergs of the Antarctic. Mr. Borchgrevink in December last again penetrated to Cape Adare, successfully landed his party at that point, and is now wintering on the Antarctic continent. The expeditions of Lieutenant Peary, of Professor Nathorst, of Captain Sverdrup, and of the Duke of Abbruzzi, which are now in progress, may be expected to yield much new information about the condition of the Arctic Ocean. Mr. Wellman has just returned from the north of Franz Josef Land, with observations of considerable interest.

Some of the scientific results obtained by the expeditions in the Danish steamer *Ingolf* have lately been published, and these, along with the results of the joint work pursued for many years by the Swedes, Danes, and Norwegians, may ultimately have great economic value from their direct bearing on Fishery problems, and on weather forecasting over long periods of time.

Largely through the influence of Professor Otto Pettersson an International Conference assembled at Stockholm a few months ago, for the purpose of deliberating as to a programme of conjoint scientific work in the North Sea and northern parts of the Atlantic, with special reference to the economic aspect of sea-fisheries. A programme was successfully drawn up, and an organization suggested for carrying it into effect; these proposals are now under the consideration of the several States. The Norwegian Government has voted a large sum of money for building a special vessel to conduct marine investigations of the nature recommended by this conference. It is to be hoped the other North Sea Powers may soon follow this excellent example.

The various marine stations and laboratories for scientific research in all parts of the world furnish each year much new knowledge concerning the ocean. Among

our own people the excellent work carried on by the Marine Biological Association, the Irish Fisheries Department, the Scottish Fishery Board, the Lancashire Fisheries Committee, the Cape and Canadian Fisheries Department, is well worthy of recognition and continued support. Mr. George Murray, Mr. H. N. Dickson, Professor Cleve, Professor Otto Pettersson, Mr. Robert Irvine, and others have, with the assistance of the officers of the Mercantile Marine, accumulated in recent years a vast amount of information regarding the distribution of temperature and salinity, as well as of the planktonic organisms at the surface of the ocean. The papers by Mr. H. C. Russell on the icebergs and currents of the Great Southern Ocean, and of Mr. F. W. Walker on the density of the water in the Southern Hemisphere, show that the Australian colonies are taking a practical interest in oceanographical problems.

Proposed Antarctic Explorations.

The great event of the year, from a geographical point of view, is the progress that has been made towards the realization of a scheme for the thorough scientific exploration in the near future of the whole South Polar region. The British and German Governments have voted or guaranteed large sums of money to assist in promoting this object, and princely donations have likewise been received from private individuals, in this connection the action of Mr. L. W. Longstaff in making a gift of 25,000*l.*, and of Mr. A. C. Harmsworth in promising 5,000*l.*, being beyond all praise.

There is an earnest desire among the scientific men of Britain and Germany that there should be some sort of coöperation with regard to the scientific work of the two expeditions, and that these should both sail in 1901, so that the invaluable gain attaching to simultaneous observations may be secured. Beyond this nothing has, as yet, been definitely settled. The members of the Association will presently have an opportunity of expressing their opinions as to what should be attempted by the British Expedition, how the work in connection with it should be arranged, and how the various researches in view can best be carried to a successful issue.

I have long taken a deep interest in Antarctic exploration, because such exploration must necessarily deal largely with oceanographical problems, and also because I have had the privilege of studying the conditions of the ocean within both the Arctic and Antartic circles. In the year 1886 I published an article on the subject of Antarctic. Exploration in the 'Scottish Geographical Magazine.' This article led to an interesting interview, especially when viewed in the light of after events, for a few weeks after it appeared in type, a young Norwegian walked into the *Challenger* office in Edinburgh to ask when the proposed expedition would probably start, and if there were any chance of his services being accepted. His name was Nansen.

When at the request of the President I addressed the Royal Geographical Society on the same subject in the year 1893, I made the following statement as to what it seemed to me should be the general character of the proposed exploration: "A dash at the South Pole is not, however, what I advocate, nor do I believe *that* is what British Science at the present time desires. It demands rather a steady, continuous, laborious, and systematic exploration of the whole southern region with all the appliances of the modern investigator." At the same time I urged further, that these explorations should be undertaken by the Royal Navy in two ships, and that the work should extend over two winters and three summers.

This scheme must now be abandoned, so far at least as the Royal Navy is concerned, for the Government has intimated that it

can spare neither ships nor officers, men nor money, for an undertaking of such magnitude. The example of Foreign Powers—rather than the representations from our own scientific men—appears to have been chiefly instrumental in at last inducing the Government to promise a sum of 45,000*l.*, provided that an equal amount be forthcoming from other sources. This resolve throws the responsibility for the financial administration, for the equipment, and for the management of this exploration, on the representative scientific societies, which have no organization ready for carrying out important executive work on such an extensive scale. I am doubtful whether this state of matters should be regarded as a sign of increasing lukewarmness on the part of the Government towards marine research, or should rather be looked on as a most unexpected and welcome recognition of the growing importance of science and scientific men to the affairs of the nation. Let us adopt the latter view, and accept the heavy responsibility attached thereto.

Any one who will take the trouble to read, in the 'Proceedings' of the Royal Society of London, the account of the discussion which recently took place on 'The Scientific Advantages of an Antarctic Expedition,' will gather some idea of the number and wide range of the subjects which it is urged should be investigated within the Antarctic area; the proposed researches have to do with almost every branch of science. Unless an earnest attempt be made to approach very near to the ideal there sketched out, widespread and lasting disappointment will certainly be felt among the scientific men of this country. The proposed expedition should not be one of adventure. Not a rapid invasion and a sudden retreat, with tales of hardships and risks, but a scientific occupation of the unknown area by observation and experiment should be aimed at in these days.

I have all along estimated the cost of a well-equipped Antarctic Expedition at about 150,000*l.* I see no reason for changing my views on this point at the present time, nor on the general scope of the work to be undertaken by the proposed expedition, as set forth in the papers I have published on the subject. There is now a sum of at most 90,000*l.* in hand, or in view. If one ship should be specially built for penetrating the icy region, and be sent south with one naturalist on board, then such an expedition may, it will be granted, bring back interesting and important results. But it must be distinctly understood that this is not the kind of exploration scientific men have been urging on the British public for the past fifteen or twenty years. We must, if possible, have two ships, with landing parties for stations on shore, and with a recognized scientific leader and staff on board of each ship. Although we cannot have the Royal Navy, these ships can be most efficiently officered and manned from the Mercantile Marine. With only one ship many of the proposed observations would have to be cut out of the program. In anticipation of this being the case, there are at the present moment irreconcilable differences of opinion among those most interested in these explorations, as to which sciences must be sacrificed.

The difficulties which at present surround this undertaking are fundamentally those of money. These difficulties would at once disappear and others would certainly be overcome, should the members of the British Association at this meeting agree to place in the hands of their president a sum of 50,000*l.*, so that the total amount available for Antarctic exploration would become something like 150,000*l.* Although there is but one central Government, surely there are within the bounds of this great Empire two more men like Mr. Longstaff. The Government has suddenly placed the

burden of upholding the high traditions of Great Britain in marine research and exploration on the shoulders of her scientific men. In their name I appeal to all our well-to-do fellow-countrymen in every walk of life for assistance, so that these new duties may be discharged in a manner worthy of the Empire and of the well-earned reputation of British Science.

JOHN MURRAY.

RECENT PROGRESS IN OCEANOGRAPHY.

UNDER the title 'On the Laws of Movement of Sea-Currents and Rivers,' Dr. A. W. Cronander, of the Technical School at Noorköping, Sweden, has recently published a volume, giving the results of researches based upon his observations of

currents at different depths, taken in 1875–1877 from the lightships in the Baltic, the Great Belt and the Sound. Similar observations on the rivers Göta Elf and Motala Ström in Sweden, in the years 1893–1895, are also utilized together with the regular daily observations of winds and surface currents, recorded on the lightships in the Baltic and in the passages leading thence to the North Sea.

These results are certainly very interesting as they establish the fact that the currents in the Baltic obey the winds and that none of the other causes, to which we are accustomed to attribute motions in sea water, such as differences in density and temperature, and affluence of rivers, produce any currents which are either distinctive or perceptible.

Under the assumption that Dr. Cronander's investigations are not readily accessible to many of those interested in these matters, I propose, with his approbation, to furnish a short résumé to this journal.

Dr. Cronander takes up the question of the existence of a current from the Baltic into the North Sea, on account of difference of level. This difference has been determined by precise leveling, between the Bothnian Gulf, near Sundwall, and Levanger, near the Frith of Trondhjem, and is 0.725 m. On account of the difference in specific gravity, which is assumed at 1.027 in the North Sea, and 1.003 in the Bothnian Sea, the difference of level has been calculated to be 0.546 m. This would give a fall of the Baltic current of 1 to more than 3,000,000, and since it has been demonstrated that with an inclination of 1 : 500,000 the motion of water is hardly perceptible, it is concluded that difference of level between the Baltic and North seas cannot produce any appreciable currents.

But it has been tacitly assumed that in consequence of the great quantities of fresh water which are constantly precipitated into the Baltic by some 250 rivers (among them five of the larger ones in Europe), there must exist a surface current, the so-called *Baltic Current*, by which this excess of water is carried off into the North Sea.

Dr. Cronander finds two alternate currents in the passages leading to the North Sea, which are controlled solely by the

winds. With easterly winds (N. N. E., to S. S. E.), the water flows into the North Sea through all these channels, and with westerly winds (N. N. W., to W. S. W.), the current reverses from the North Sea into the Baltic. The difference between the quantity of water which, within a specified time, is carried out of the Baltic and into it, indicates the quantity which has been definitely removed from the Baltic within the time, and furnishes an indication of the force of the Baltic current; hence the current has no specific existence but only a differential one.

Assuming t to be the time during a year when outgoing currents prevail, and v the mean velocity, likewise t' the length of time for inflowing currents during the period, and v' their mean velocity, the mean velocity of the Baltic current will be given by the formula

$$V = \frac{vt - v't'}{t + t'}.$$

Dr. Cronander has calculated this velocity for the sound for two decades, 1850–59 and 1864–73, and obtained for the first period $v = 1.204$, $v' = 1.304$ and $V = 0.257$ and for the second period $v = 1.153$, $v' = 1.230$ and $V = 0.210$ (velocities in knots per hour). It will be noticed that the mean current from the North Sea is stronger than that from the Baltic, and since, in spite of this, more water is conveyed from the Baltic than into it, the outgoing current must be of greater duration. Similar calculations have also been made for the Great Belt, but only for the term of a few years; they show that in some years more water flows through this passage *into* the Baltic than *out* of it. These measures of velocity apply to the surface only, and now the important question comes up, to what depth is the current propagated and what is the law of decrease with increasing depth?

Currents which are caused directly by the winds, denominated '*drift currents*,' show a very rapid decrease of velocity with increase of depth in consequence of friction, as indicated in the adjoining diagram (A); in rivers, where the velocity is due to the difference of level, the decrease of velocity with the depth is very gradual as shown by the accompanying diagram (B). The difference in the shape of these diagrams is so apparent that nobody can make a mistake in deciding whether a given current belongs to one or the other of the two classes.

Now Dr. Cronander found that wherever he measured the currents under the surface, whether in the Baltic, the Sound, the Belt, or the Cattegat, the observations always pointed to differences of level as the cause, and against a supposition of a direct effect of the winds. This is then another important conclusion which Dr. Cronander reached, viz.: that although the currents of the Baltic appear to obey the winds, the winds are not the immediate cause, but the difference of level created by preceding winds. To illustrate: Supposing a strong westerly wind to have been blowing over the Baltic, it will produce an accumulation of water in the eastern and northern part, and a corresponding depression of level in the western part. As soon as these westerly winds are replaced by easterly ones, the pent up waters will flow in an easterly direction, more in consequence of reaction against the preceding westerly winds, than in obedience to existing easterly winds. It must be observed that the greatest velocities were not generally found at the surface. Thus, in the Sound the average velocity of the outgoing current, 3.55 decimeters per second, was found at the surface; that of the ingoing current, 3.66 decimeters at the depth of 1 fathom. For the Great Belt, the corresponding figures were 3.81 decimeters at 4 fathoms for the outgoing, and 3.78 at 6 fathoms for the ingoing current. The shift of greatest velocity from a surface to a

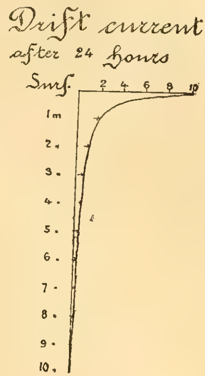
lower plane is satisfactorily explained by the interference of local winds with the direction of the surface currents.

The existence of a heavier layer of salt water in the deeper part of the Baltic has been generally attributed to the existence of an undercurrent from the North Sea into the Baltic. Dr. Cronander found no traces of such an undercurrent in the shallow part of the Sound, where, at 5 fathoms depth, the ingoing and the outgoing currents each reached to the bottom. He compares the movement of the water here to that of two wedges, one of fresh water at the surface which has its base in the Baltic, and superposed upon one of salt water which has its base in the North Sea; both wedges are driven as a whole backward and forward by the currents, with the effect that sometimes the whole Sound is nearly filled with fresh water and at other times with salt water.

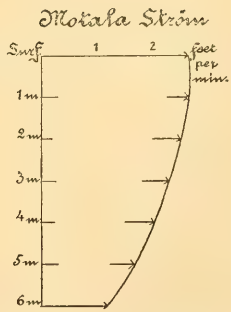
In the Great Belt the conditions were found to be somewhat different. With strong easterly or westerly winds, the outgoing or ingoing currents reach to the bottom, but sometimes the brackish water from the Baltic combines with the salt water from the North Sea in the shallow part of the Belt, and constitutes a homogeneous water-mass which is moved forward and backward. Again, sometimes a distinct bottom current is formed which moves in an opposite direction to the surface current. With low water in the Baltic, and an outgoing surface current, an ingoing bottom current may arise; and with high water in the Baltic, and ingoing surface current, an outgoing undercurrent may be called into existence.

From these statements we conclude that the assumed undercurrent from the North Sea into the Baltic does not present the normal condition, but that undercurrents into and out of the Baltic may occasionally be called into existence in the Great Belt by an effort of water at the bottom, to restore the hydrostatic equilibrium when it has been disturbed at the surface, and such a restoration at the surface is prevented by

A



B



the winds. Hence, we may assume that the greater part of the salt water, which we find at the bottom of the Baltic, finds its way into it by surface currents, and that by reason of its weight and loss of heat by contact with the colder water, it settles to the bottom.

In the northern Baltic, two alternating sets of currents were found; an outgoing one, coming from a N. N. E. direction with

a mean velocity of 1.06 decimeters per second at the surface, and 0.20 decimeter at the bottom in 55 m. depth, and an ingoing current from S. W., to W. S. W. with 2.16 decimeters velocity at the surface and 0.37 decimeter at the bottom. With strong winds the currents extended all the way to the bottom; with feeble winds still water is found at the bottom. Contrary local winds often produce still water or drift currents at the surface, when the main current is outgoing, but the stronger inflowing current is seldom stopped by contrary winds.

The salt determinations in the northern Baltic show a surface layer of 15–20 m. deep with an average saltness of 5.6 to 5.7 grammes of salt to the liter; between 20 and 45 m. a mixed layer of 6 to 7.3 grammes; and between 45 and 55 m. a nearly homogeneous bottom layer of 7.5 to 7.7 grammes of salt, which shows scarcely any variation during different seasons. This bottom layer also shows but slight changes of temperature; between June 11 and August 16, 1877, the temperature rose from 0°.5 to 1°.6, while at the surface during the same time it rose from 4°.6 to 17°.5.

Thus far I have followed Dr. Cronander, but I feel tempted, before concluding, to make a few remarks concerning the conclusions reached, and also to apply the results obtained towards the explanation of some of the more prominent ocean currents, which he has refrained from doing.

In the estimate of the Baltic current, based on difference of level between the Baltic and North Sea, a uniform slope of 1: 3000000 from the head of the Baltic to the North Sea has been assumed. It appears quite probable to me that, on account of the obstruction which the narrow and shallow passages interpose to the free passage of water between these two seas, the surface of the Baltic will be nearly on a perfect level and that at its juncture with the North Sea there will be a much greater difference of level than that indicated by a slope of 1: 3000000 and quite sufficient to produce perceptible currents in the Sound and Great Belt. In a critical examination of the currents in these two passages, I think the tidal currents should have received some consideration. The rise of the tide in different parts of the Baltic furnishes the means of determining the strength of these currents; and, however small it may be, the figures should have been produced just as has been done with the so-called Baltic Current. Furthermore, I am willing to admit that Dr. Cronander's observations prove that in the open Baltic the currents move in obedience to laws identical with those governing the flow of rivers; but in the Sound and Great Belt the direction and flow of currents are so greatly modified by contraction of the channels, that a current, which in the open Baltic or North Sea might be considered a mere drift current, could be easily changed into a veritable river current.

The equatorial currents appear to me to be fair examples of surface currents which derive their strength solely from the action of the trade winds. Unfortunately, deep-sea current observations are not at hand, but, if the above supposition holds, their depth cannot be very great. The current through the Strait of Yucatan, which at the surface surpasses the strength of all the Gulf Stream waters, is assumed to be due to the partial barrier, namely, Yucatan and Cuba, between the Caribbean Sea and the Gulf of Mexico. According to Pillsbury's observations, I estimate its depth at 200 fathoms. The undercurrent from the Gulf of Mexico, which I am led to believe exists, from comparison of the quantities of water that enter the Gulf and leave it through the Strait of Florida, may possibly be explained upon the same grounds as those undercurrents occasionally met with in the Great Belt, viz., an effort towards the restoration of

equilibrium, disturbed at the surface by the effect of the winds. The conditions are nearly identical. In the Baltic, easterly winds and currents force the waters into the North Sea, raise the level of the Great Belt, and give rise to an undercurrent from the North Sea into the Baltic. Here we assume that the waters, which the equatorial currents succeed in piling up in the western part of the Caribbean Sea, seek a passage through the Yucatan Strait into the Gulf of Mexico; that in this passage the level stands higher than on either side, and that the water forced into the Gulf of Mexico raises its level over that of the eastern portion of the Caribbean Sea. Since equilibrium cannot be restored at the surface, it is done by an undercurrent from the Gulf. Somewhat different from these conditions are those which are supposed to govern the flow of the Gulf Stream from the Gulf of Mexico into the Atlantic. Pillsbury's current observations in the Strait of Florida show that in the narrow parts the current touches bottom. There remains little doubt at present that the Gulf Stream owes its origin to the difference of level between the Gulf of Mexico and the Atlantic. Recent precise leveling, by the Coast and Geodetic Survey, indicates that between the mean level of the ocean at St. Augustine, on the eastern coast of Florida, and that of the Gulf at Cedar Keys, on the western, there exists a difference of nine-tenths of a foot. Some surprise might be expressed that such an insignificant difference should be able to set such a powerful stream into motion. But if we assume the Gulf to represent a basin, and the Strait of Florida a narrow orifice by which it communicates with the Ocean and apply Torricelli's theorem, neglecting friction, we obtain the velocity of $v = \sqrt{2g \times 0.9} = 7.6$ feet per second, which is not very greatly in excess of the average velocity of the Gulf Stream in the most contracted portion of the Strait.

Some authors speak of the impulse of the Gulf Stream carrying its waters against the western coast of Europe, and producing a higher level there than exists on the eastern coast of North America. Whatever impulse the Gulf Stream possesses is due to its higher level, and I cannot comprehend how such an impulse can make it ascend an inclined plane. What is meant, I presume, is the Gulf Stream drift, the motive power of which is the prevailing westerly winds of the North Atlantic. It is generally supposed that this Gulf Stream drift is compensated for by an undercurrent setting from the western shores of Europe in a southwesterly direction.

A. Lindenkohl.

OBSERVATIONS ON RHYTHMIC ACTION.

Two entirely different forms of regularly repeated action are to be distinguished. In one form the subject is left free to repeat the movement at any interval he may choose. This includes such activities as walking, running, rowing, beating time, and so on. A typical experiment is performed by taking the lever of a Marey tambour between thumb and index finger and moving the arm repeatedly up and down; the recording tambour writes on the drum the curve of movement. Another experiment consists in having the subject tap on a telegraph key or on a noiseless key and recording the time on the drum by sparks or markers. Other experiments may be made with an orchestra leader's baton having a contact at the extreme end, with a heel contact on a shoe, with dumb-bells in an electric circuit, and so on. For this form of action I have been able to devise no better name than 'free rhythmic action.'

In contrast with this there is what may be called 'regulated rhythmic action.' This is found in such activities as marching in time to drum-beats, dancing to music, playing in time to a metronome, and so on. A

typical experiment is that of tapping on a key in time to a sounder-click, the movement of the click and that of the movement of the finger being registered on a drum.

Regulated rhythmic action differs from free rhythmic action mainly in a judgment on the part of the subject concerning the coincidence of his movements with the sound heard (or light seen, etc.). This statement, if true, at once brushes aside all physiological theories of regulated rhythmic action. One of these theories is based on the assumption (Ewald) that the labyrinth of the ear contains the tonus-organ for the muscles of the body. It asserts that vibrations arriving in the internal ear affect the whole contents including the organ for the perception of sound and the tonus-organ. Thus, sudden sounds like drum-beats or emphasized notes would stimulate the tonus-organ in unison, whereby corresponding impulses would be sent to the muscles. This theory has very much in its favor. It is undoubtedly true that such impulses are sent to the muscles. Thus at every loud stroke of a pencil on the desk I can feel a resulting contraction in the ear which I am inclined to attribute to the *M. tensor tympani*. Likewise a series of drum-beats or the emphasized tones in martial or dance music seem to produce twitchings in the legs. Féré has observed that, in the case of a hysterical person exerting the maximum pressure on a dynamometer, the strokes of a gong are regularly followed by sudden increased exertions. Nevertheless, these twitchings are not the origin of the movements in regulated rhythmic action. For many years I have observed that most persons regularly beat time just before the signal occurs; that is, the act is executed before the sound is produced. Records of such persons have been published (*e. g.*, New Psychology, p. 182), but their application to the invalidation of the tonus-theory was first suggested by Mr. Ishiro Miyake. This does not exclude the use of muscle sensations, derived from tonus-twitches, in correcting movements in regulated rhythmic action, although they presumably play a small or negligible part as compared with sounds.

Another argument in favor of the subjective nature of regulated rhythmic action is found in the beginning of each experiment on a rhythm of a new period; the subject is quite at loss for a few beats and can tap only spasmodically until he obtains a subjective judgment of the period. If the tonus-theory were correct, he should tap just as regularly at the start as afterward.

The conclusion seems justified that regulated rhythmic action is a modified free rhythmic action, whereby the subject repeats an act at what he considers regular intervals, and constantly changes these intervals to coincide with objective sounds which he accepts as objectively regular.

In free rhythmic action there is one interval which on a given occasion is easiest of execution by the subject. This interval is continually changing with practice, fatigue, time of day, general health, external conditions of resistance, and so on.

"It has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work. Thus, to go to the greatest distance in steady traveling day by day the horse or the bicyclist must move his limbs with a certain frequency; not too fast, otherwise fatigue cuts short the journey, and not too slow, otherwise the journey is made unnecessarily short. This frequency is a particular one for each individual and for each condition in which he is found. Any deviation from this particular frequency diminishes the final result."

It is also a well-known fact that one rate of work in nearly every line is peculiar to

each person for each occasion, and that each person has his peculiar range within which he varies. Too short or too long a period between movements is more tiring than the natural one in walking, running, rowing, bicycling, and so on.

It is highly desirable to get some definite measurement of the difficulty of a free rhythmical action. This cannot well be done by any of the methods applicable to the force or quickness of act, but it may be accomplished in the following manner:

As a measure of the irregularity in a voluntary act we may use the probable error. When a series of measureable acts are performed they will differ from one another, if the unit of measurement is fine enough. Thus, let $x_1, x_2, \cdots, x_n$ be successive intervals of time marked off by a subject beating time, or walking, or running, at the rate he instinctively takes. The average of the measurements,

$$a = \frac{x_1 + x_2 + \cdots + x_n}{n},$$

can be considered to give the period of natural rhythm under the circumstances. The amount of irregularity in the measurements is to be computed according to the well-known formula:

$$p = \sqrt{\frac{v_1^2 + v_1^2 + \cdots + v_n}{n - 1}}$$

where $v_1 = x_1 - a$, $v_2 = x_2 - a$, $\cdots$, $v_n = x_n - a$. The quantity p is known as the 'probable error,' or the 'probable deviation.' The quantity

$$r = \frac{p}{a},$$

the 'relative probable error,' expresses the probable error as a fraction of the average.

If all errors in the apparatus and the external surroundings have been made negligible, this 'probable error' is a personal quantity, a characteristic of the irregularity of the subject in action. If, as may be readily done, the fluctuations in the action of the limbs of the subject be reduced to a negligible amount, this probable error becomes a central, or subjective, or psychological, quantity. Strange as it may appear, psychologists have never understood the nature and the possibilities of the probable error (or of the related quantities, 'average deviation,' 'mean error,' etc.). In psychological measurements it is—when external sources of fluctuation are rendered negligible—an expression for the irregularity of the subject's mental processes. Nervous or excitable people invariably have large relative probable errors; phlegmatic people have small ones.

Thus a person with a probable error of 25% in simple reaction time will invariably have a large error in tapping on a telegraph key, in squeezing a dynamometer, and so on. I have repeatedly verified this in groups of students passing through a series of exercises in psychological measurements. I do not believe it going too far to use the probable error as a *measure* of a person's irregularity. This is equivalent to asserting that a person with a probable error twice as large as another's is twice as irregular, or that if a person's probable error in beating time at one interval is r_1 and at another interval r_2, his irregularity is r_1 times as great in the second case as in the first. This concept is analogous to that of precision in measurements. We might use the reciprocal of the probable error as a measure of regularity. The positive concept, however, is in most minds the deviation, variation or irregularity, and not the lack of deviation, the non-variability, or the regularity. In the case of the word 'irregularity' the negative word is applied to a concept that is naturally positive in the average mind.

The irregularity in an act is a good expression of its difficulty. Thus, if a person beating time at the interval T has an ir-

regularity measured by the probable error P and at the interval t a probable error p, it seems justifiable to say that the interval t is $\frac{p}{P}$ times as difficult as T. If T is the natural interval selected by the subject, then the artificial interval t would be more difficult than T, and we should measure the difficulty by comparing probable errors.

It is now possible to state with some definiteness the law of difficulty for free rhythmic action. Let T be the natural period and let its probable error—that is, its difficulty—be P. It has already been observed (SCIENCE, 1896, N. S., IV., 535), that any other larger or smaller period (slower or faster beating) will be more difficult than the natural one and will have a larger probable error. Thus any interval t will have a probable error p which is greater than P, regardless of whether t is larger or smaller than T.

Three years ago (SCIENCE, as above) I promised a complete expression for this law. Continued observations during this time enable me to give an idea of its general form. The results observed can be fairly well expressed by the law

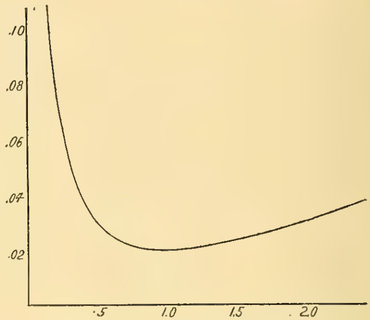
$$p = P\left(1 + c\frac{[t - T]^2}{t}\right)$$

in which T is the natural period, P the probable error for T, t any arbitrary period, p the probable error for t and c a personal constant.

This may be called the law of difficulty in free rhythmic action. A curve expressing the equation for $T = 1.0^s$, $P = 0.02^s$ and $c = 1$ is given in the figure.

It will be noticed that periods differing but little from the natural one are not much more difficult and that the difficulty increases more rapidly for smaller than for larger periods.

In plotting this curve I have assumed unity as the value for all personal constants. The personal constants will undoubtedly vary for different persons, for different occasions and for different forms



of action; an investigation is now in progress with the object of determining some of them.

In case it is desired to know what periods are of a difficulty 2, 3, ···, n times that of T, a table of values for p may be drawn up in the usual way and that value for t sought for (with interpolation) which gives for p a value 2, 3, ···, n times as great. Thus, in a table for the above example it is found that the periods 0.38^s and 2.6^s are twice as difficult.

This law can be stated in another form which is of special interest to the psychologist. To the person beating-time a period of 0 is just as far removed from his natural period as one of ∞ ; both are infinitely impossible. The objective scale does not express this fact; objectively a period of 0 is as different from a period of 1^s as a period of 2^s would be. Similar considerations hold good for the lesser periods; the scale by which the mind estimates periods is different from their objective scale. This difference may be expressed by asserting that the following relations exist between the two:

$$x = c\frac{(t - T)^2}{t}$$

where x is the measure on the mental scale, T the natural period, t any other period, and c a personal constant. By this formula the various periods may be laid off according to their mental differences from the natural period. Every difference from the natural period is mentally a positive matter. With the mental scale the law of difficulty becomes

$$p = P\,(1 + cx)$$

where p and P are the probable errors for t and T respectively, x is the measure on the mental scale and c is a personal constant. This is the equation of a straight line. The law states that the difficulty of any arbitrary period is directly proportional to its mental difference from the natural period. This is the statement which I tried to make in the note published in Science, 1896, N. S., IV., 535.

This law of difficulty as depending on the period is, of course, only one of the laws of free rhythmic action. It is quite desirable that other laws of difficulty and of frequency should be determined. For example, observations on ergograph experiments tend to show that the irregularity and the natural period both change with the weight moved; they also change with the extent of the movement.

Such a series of well established laws might be useful in regulating various activities to the best advantage. It is already recognized that it is most profitable to allow soldiers on the march to step in their natural periods; it is also known that on the contrary sudden and tense exertion is favored by changing the free rhythmic action into regulated action by marching in step and to music. More definite knowledge might perhaps be gained concerning the most profitable adjustments of the rhythm and extent of movement in bicycle-riding to the person's natural period; at present only average relations are followed in the adjustment of crank-length, gear and weight to bicycle-riders, individual and sex differences not being fully compensated. Other examples will suggest themselves.

Not only does every simple activity have its own natural rhythms; combinations of activities have rhythms that are derived from the simpler ones. In fact, it may be said that the individual, as a totality, is subjected to a series of large rhythms for his general activity (*e. g.*, yearly, monthly, weekly, daily, and so on), and also to a series of smaller rhythms for his special activities. The natural periods do not always correspond with the enforced periods. The daily rhythm is unquestionably too slow for some persons and too rapid for others; the unavoidable enforcement of the 24-hour period works a loss to all who would naturally vary from it, and diminishes the total amount of work that could be produced by them. For large numbers of brain-workers the 24-hour period is too long; for many of them the natural period is probably about 18 hours. Although about one-quarter of the day is not efficiently used, there is little relief in splitting up the day into parts, because (1) the 12-hour period would be naturally even less advantageous than the 24-hour one, and (2) the rhythm of the environment cannot be made to fit.

The progress of civilization and the changes in life are undoubtedly tending to shorten the natural period from 24 hours by encouraging a greater discharge of energy at shorter intervals. Since the 24-hour rhythm is a fixed one, there must be a constant effort at adjustment in this respect by those individuals most susceptible to the new influences. The survival of the fittest will, of course, tend to keep the natural rhythm not far from the 24-hour period.

E. W. Scripture.

Psychological Laboratory,
Yale University,
August 1, 1899.

GEOLOGY AT THE BRITISH ASSOCIATION.

The address of the President of the Section, Sir Archibald Geikie, already published in this Journal was conspicuous for the definiteness of its reliance on geological evidence as opposed to that derived from physical principles. He claimed, it will be remembered, that the importance of this evidence had never been weighed or appreciated by Lord Kelvin, while not a few physicists, including Darwin and Perry, are not in agreement with Lord Kelvin as to the extreme limitations imposed by his more recent estimate. It is interesting to note that almost simultaneously with the British Association meeting, there was published by the Royal Dublin Society a paper by Professor Joly in which he calculates that if the sodium in the sea and preserved in beds of rock salt were all derived by denudation from rocks in the earth-crust, at the present known rate of transport by rivers, from 80,000,000 to 90,000,000 years would have been necessary for its accumulation.

On account of the visit of the French and Belgium Geologists the President's address was not given till Saturday. The proceedings of the Section were therefore opened by papers on the South Eastern Coalfield, an account of which has already appeared in the columns of Science. Germane to this subject was a short note by Mr. Jukes-Browne on a boring through the Chalk and Gault near Dieppe. Beneath the sandy base of the Gault clay the waterbearing lower greensand was met with, and the section proved that the Folkestone and Wissant facies of the Gault extended for 52 miles southward.

No papers on the more ancient rock systems were read during the meeting, the earliest rocks dealt with being the carboniferous. Mr. Gibson's recent work in the North Staffordshire Coalfield is interesting not only because his important economic results flow chiefly from work in rocks of no economic value, but because it shows that detailed scientific work may reveal facts of important economic value even in a region pierced in every direction by mine shafts and worked continuously for centuries. For many coming years in Britain most vital facts, from a commercial point of view, with regard to the distribution of coal and iron, will be gradually accumulated by borings and sinkings through the neozoic rocks. Unless a systematic record of these borings is kept at a central bureau, their value to the nation will be lost and work will have to be done over again by private individuals, at a cost of millions. Much of this might be saved if observations are accumulated as they are obtained so as to give a good idea of the sub-triassic structure of the whole country.

Mr. Greenly exhibited photographs of funnel-shaped 'pipes' bored through the carboniferous limestone of Anglesey and filled with deposits of sandstone continuous with the beds above. The report of Mr. Garwood on the zoning of the British carboniferous rocks shows that though the difficulties surrounding this subject are lessening they have not yet been cleared away. Most of the zone fossils hitherto employed are not capable of more than restricted local use.

Mr. Wedd finds that in places the Bunter sandstone is cemented with barium sulphate, a fact frequently noted in the basal beds of the Keuper sandstones. Professor Watts described and showed photographs of the surface of the granite under the Keuper marls of Leicestershire. This possessed many of the features of wind eroded rocks, and one piece of granite exhibited was grooved and polished and presented an appearance recognized by many geologists present as characteristic of Æolian action.

The following new classification of the Pliocene deposits of the east of England was proposed by Mr. F. W. Harmer ; Older Plio-

cene including the Lenhamian (Lenham Beds); newer Pliocene including Gedgravian (Coralline Crag); Waltonian (Walton and Oakley horizons); Newbournian, Butleyan, Icenian (Norwich Crag); Chillesfordian and Weybournian (Weybourne Crag and Forest Bed Series). The same author pointed out that shell accumulations comparable to the 'crags' are now only found on shores, such as Holland, open to prevalent southwesterly gales. He suggests that in Pliocene times Scandinavia may have been anticyclonic, diverting the winds in eastern England so that easterly gales were common. He further suggests that during the Glacial Epoch the ice-sheet of northern Europe might have been an anticyclonic center like Greenland at the present day. Evidence in favor of ice-sheet action in Anglesey was furnished in a paper by Mr. Greenly and Mr. Kendall reported on Erratic Blocks, dealing chiefly with Scandinavian and Cheviot boulders in Yorkshire. Mr. Lomas proposed to restrict the term 'moraine' to stationary deposits and the word 'rock-train' to *débris* riding on or moving with the ice.

The investigations carried on by a committee, of which Sir William Dawson is chairman and Professor Coleman secretary, succeeded in demonstrating, after meeting with many difficulties, that the warm climate beds of the Don Valley in Canada underlie the cold climate beds of Scarborough and that both series, underlain and covered by boulder clays, were interglacial in age. The fossil leaves and wood will be determined in time for the final report next year.

The committee on Irish elk remains in the Isle of Man has not as yet succeeded in its principal task. The committee on the Ty Newydd Caves in North Wales presented their final report in which they correlated the successive deposits with those of the Ffynnon Benno Caves, studied by Dr. Hicks, and concluded that the deposits in them were earlier than the boulder-clay of the district with northern and western erratics.

The exhibition of specimens of Eolithic and Paleolithic flints, including one obtained by Dr. Kerr from Folkestone, led to a brisk discussion on the antiquity of man, in which Sir John Evans, one of the first Englishmen to study the gravels of the Somme with Boucher de Perthes, declined to admit that the so-called Eolithic implements furnished any evidence of the existence of pre-Paleolithic man. This opinion he reiterated in a short paper read in the Boulogne Museum on the occasion of the visit of the Association to that town at the end of the meeting.

Amongst the paleontological papers may be mentioned Professor Rupert Jones' report on Paleozoic Phyllopoda, and an interesting exhibition by Dr. Rowe of slides, showing recent developments of photo-micrography of opaque objects as applied to the delineation of the minute structure of fossils. Professor Sollas initiated a discussion on homotaxy and contemporaneity, in which he concluded that the geological clocks in different localities were, figuratively speaking, never more than minutes and seldom more than seconds wrong.

Professor Renard announced that by subjecting quartzite, enveloped in an alloy, to hydrostatic pressure equal to 5,000 atmospheres, he had produced granulation in the quartz identical with that seen in silicate meteorites. Professor Sollas was able to bring positive proof of the existence of abundant sponge spicules in the chalk which are now represented by hollow casts to the extent of sometimes 3 per cent. of the rock.

Some beautiful examples of wave photographs were shown by Mr. Vaughan Jennings, including waves in rock, lava, mud, sand, soil-terraces and sand dunes. Dr. Tempest Anderson exhibited photographs

of the eruption of Vesuvius in 1898, and read a note by Professor Plalania on the recent eruption of Etna.

An interesting investigation, initiated by Professor Kendall and others, is being carried on to ascertain the course of the underground waters in the Craveri (Carboniferous Limestone) district of Yorkshire. Common salt, salts of ammonia, and fluorescin were placed in quantity in the 'sinks' and the water issuing miles away was periodically analyzed with the result of tracking the course of several underground drainage systems.

The Geological Photograph Committee exhibited a large series of prints and gave an account of the year's collection. It was resolved to publish a representative series of geological photographs if sufficient support was guaranteed to make the scheme self-supporting.

W. W. Watts.

SCIENTIFIC BOOKS.

The Mysterious Mammal of Patagonia, Grypotherium Domesticum. By Rudolph Hauthal, Santiago Roth and Robert Lehmann Nitsche. Revista del Museo de La Plata. Vol. IX. Pp. 409–474.

Under the above title the authors have issued a series of papers containing 65 pages of text and accompanied by five plates; dealing principally with that curious mammal to which Dr. Ameghino some two years ago gave the name of Neomylodon Listai.

Ameghino based his generic and specific descriptions upon a few small endermal ossicles and certain stories or traditions said to be current among the Indians of Patagonia concerning the existence of such an animal, and upon verbal descriptions of a piece of skin presumably belonging to a large gravigrade edentate. This piece of skin was found in a dessicated condition by Dr. Otto Nordenskjöld and Mr. Hermann Eberhard in a cavern near Consuelo Cove, in Last Hope Inlet, on the west coast of southern Patagonia.

Dr. Ameghino's announcement aroused great interest and has been frequently noted, both in scientific and popular journals, chiefly on account of the opinion advanced by him that this great sloth still exists in the interior of Patagonia and at present causes extreme terror among the Indians by its intensely predaceous habits!

During the past season Dr. Hauthal visited the cave from which the first piece of skin was obtained by Dr. Nordeskjöld and was successful in securing other pieces of skin associated with many bones and parts of skulls, showing the complete dentition. Associated with these remains he also found bones of other animals, principally belonging to the following genera: *Homo*, *Felis*, *Canis*, *Equus*, *Onohippidium*, *Auchenia*, *Mephitis*, *Rhea*, etc., together with stone and bone implements, mingled with charcoal and charred fragments of bones.

Dr. Hauthal gives a description of the cave with a diagram, showing where the more important finds were made. He also mentions several other unexplored caves in the same neighborhood.

Dr. Roth gives a classification and description of the different mammalian remains found, and reaches the conclusion that the sloth to which the skin, described at second hand by Ameghino belonged, does not represent a new genus. This is shown by a study of the skulls, teeth and other parts of the skeleton, found associated with pieces of skin, and which, according to Roth are not generically distinguishable from Grypotherium of Reinhardt, from the Pampean beds further north.

Dr. Roth places little reliance on the tales purporting to come from the Indians regarding the terrible animal frequenting regions adjacent to the larger lakes and rivers of the interior and which are said to attack and carry off their horses. He believes that at most this is only a tradition among them of the former existence of a very large cat, a few remains of which were found in the cave, and which though at present extinct may have existed contemporaneously with the present Indians of Patagonia several generations ago.

The habits attributed to this terrible animal, according to Ameghino by the Indians, are certainly more like those we should expect to find

among the larger members of the Felidæ than among the slow moving, inoffensive and herbivorous Edentates. Consequently if there be any truth whatever in these tales or traditions they probably refer to this large cat. Dr. Roth has referred these cat remains to Ameghino's species, retaining the specific name of Listai proposed by Ameghino. He rejects the generic name of Neomylodon, which would then clearly be a misnomer and substitutes the Indian name of Iemisch by which, according to Ameghino, the animal is known among the Indians. Two objections may be offered to this generic name, first its barbarous origin, which though not absolutely prohibited by rules governing the formation of such names should nevertheless be discouraged, and second, the material upon which it is based has not been shown to be distinct from either Smylodon or Felis.

In *Iemisch Listai* we have an instance in Zoological Science, which if not unique, it surely ought to be, of a species in which the original type may be fairly said to consist of traditions, collected among an entirely uncivilized people. For it is upon these Indian tales that the description given by Dr. Ameghino not only as to the habits but also as to the color, number and character of the toes on each foot, size of head, length and prehensile nature of tail, etc., are based.

Regarding the existence of such traditions among the Indians of Patagonia, I can only say that during the three years spent by myself there, during which I was frequently thrown among the southern Indians, I learned of no such traditions from the Indians themselves. If any such traditions exist among them, they certainly have not engendered that feeling of terror and fear of this animal as pictured by Ameghino, for I have frequently camped with the Indians in regions said by Ameghino to be the traditional or reported haunts of Iemisch, and have never observed them to take any special care for themselves or their horses, leaving the latter loose, picketed and hobbled in great numbers night and day alike.

From a study of the cave and the condition in which the remains were found, Dr. Hauthal concludes that man and all the other animals of which associated remains were found, coëxisted here during an interglacial period and that these caves were occupied as habitations by the men who shared them with certain domesticated animals among which was the large Edentate, *Grypotherium domesticum*. This opinion is also shared by Dr. Roth and less strongly, if I mistake not, by Dr. Nitsche who discusses the material from an archæologic standpoint.

The papers are extremely interesting and are important not only for the light they throw on the nature of the '*Mysterious Mammal of Patagonia*,' but also for the additional evidence afforded of the existence of representatives of the Pampean fauna in comparatively very recent times. We may expect further explorations of these cave deposits to bring to light additional remains and perhaps establish their correlation with deposits in the north.

J. B. Hatcher.

Maryland Weather Service. Volume I. Baltimore, Md., The John Hopkins Press. 1899. 4to. Pp. 566. Charts LIV. Figs. 61.

If the succeeding volumes of the Maryland State Weather Service are kept up to the standard and size of the first volume, and if the scheme of work outlined in the present publication is followed out, it is safe to say that a new era has opened for climatology in this country. That this rich promise for the future will be fulfilled no one can doubt who knows the men in charge of, and interested in the Maryland Weather Service, and who appreciates the peculiarly favorable position which this service occupies, carried on as it is under the joint auspices of the Johns Hopkins University and of the United States Weather Bureau.

The Director of the Service is Professor William B. Clark, of Johns Hopkins University, whose special interest in geology has never caused him to neglect the scientific study of meteorology. The Secretary and Treasurer is Professor Milton Whitney, Chief of the Division of Soils of the Department of Agriculture, who represents the Maryland Agricultural College, and is well known in connection with his work on the relations of soils to climate and crops. The Meteorologist in charge is Mr. F. J. Walz, of the United States Weather Bureau, who is

detailed by the Chief of the Bureau to supervise the Weather Service work in Maryland, and who has carried on this work most successfully for several years. Dr. Oliver L. Fassig, Instructor in Climatology in Johns Hopkins University, and also an official of the United States Weather Bureau, who contributes an important paper to this volume, has been doing most effective work at his university through his lectures, and through his unique but most valuable summer field courses in observational meteorology. Dr. Fassig was formerly Librarian of the United States Weather Bureau in Washington; he has had the advantage of study under the leading European meteorologists, and under Professor Cleveland Abbe, the foremost meteorologist in this country, and is doing a great deal to further the advance of scientific meteorology in the United States. Finally, Professor Abbe himself, although not officially connected with the Maryland Weather Service, has had a great interest in its work, and has shown his interest by recently presenting the whole of his valuable meteorological library to Johns Hopkins University. In addition to this most happy association of men, admirably equipped for their work, the Maryland Weather Service has had the heartiest coöperation on all sides from National and State scientific departments.

We have spoken at some length of the personnel of the Maryland Weather Service, because such men are bound to produce excellent results, and this is the secret of the high quality of the present volume, which is emphatically *bahnbrechend.* It remains for us to note, as briefly as may be, the contents of the book.

An *Introduction* by Professor Clark gives the chief facts regarding the establishment of the Weather Service, and discusses the scope of the work now being carried on, or proposed for the future. We agree thoroughly with the Director in his views as to the range of subjects which fall within the limits of climatologic study. We believe, with Professor Clark, that climate cannot be studied without a knowledge of the physiography of the region under discussion, and that the disposition of the rainfall, the relations of the climate to health and disease, the character of forest growth, the distribution of plant and animal life, the relations of climatic conditions to human life and activities, these, and still other topics, deserve treatment in a complete investigation of any climate.

A general report on the Physiography of Maryland follows the introduction. This report, by Dr. Cleveland Abbe, Jr., is just in the right place in the volume. A physiographic basis is essential to the scientific study of climates; therefore the surface features of a country need consideration before the meteorological data are discussed. Dr. Abbe's report is written from the point of view of the new geography, and is clearly the result of careful and extended study. Doubtless this report will shortly be reviewed in this Journal, and further mention of it is therefore omitted. A word may, however, be said regarding the illustrations, in the way of maps, sections and heliotype views, which serve to give the student of climatology who has the misfortune not to know Maryland from his own observations, a vivid idea of the chief topographic features of the state.

Part III., a report on the meteorology of Maryland, was prepared, by direction of Willis L. Moore, Chief of the Weather Bureau, by Professor Cleveland Abbe, Dr. Oliver L. Fassig and Mr. F. J. Walz. The first paper, by Professor Abbe, concerns the *Aims and Methods of Meteorological Work especially as conducted by National and State Weather Services.* This paper is divided into several sections, the first of which, on *Dynamic Meteorology and its Applications*, deals with the history of weather maps, clouds and cloud charts, weather forecasts and analytical and experimental research work in meteorology. This section is illustrated by means of the Hydrographic Office colored cloud views, first published in 1897, and by means of a series of weather maps. Professor Abbe's interest in all that tends to the advancement of the higher meteorology is well known, and in this paper he has enumerated many problems for special research and observation, which we heartily commend to the attention of those teachers who are fortunate enough to have facilities which enable them to offer their students such work to do, and who have the students who wish to do the work. The second

section of Professor Abbe's paper concerns *Climatology and its Aims and Methods*, and deals chiefly with the relations of climate to vegetation. Some years ago Professor Abbe made a careful study of the latter subject, and, although he has never published any extended report upon it, he has often referred to the results to which his studies led him. We take it that these pages of the Maryland Weather Service volume contain a summary of the results which Professor Abbe reached, and we welcome them as giving the best brief statement of the most important facts in the complicated interrelations of climate and the products of the soil. Soil temperatures; the climatic influence of forests and agriculture; reforestation; the geographical distribution of plants, etc., are considered. The third section of Professor Abbe's report deals with *Apparatus and Methods*, and is the first publication on this subject we have yet seen which illustrates the different instruments altogether by means of photographic reproductions.

A Sketch of the Progress of Meteorology in Maryland and Delaware, by Dr. Fassig, follows, and is an extremely interesting historical account. We note, in passing, that Dr. Fassig reproduces Lewis Evans's map of 1749, which contained the famous statement concerning the movements of northeast storms from the southwest. A copy of the original map, published in 1747, Dr. Fassig was unable to find; he has therefore reproduced the second map, dated two years later. Credit has sometimes been given to Evans for the first statement of this important discovery, but it justly belongs to Franklin, as Dr. Fassig says. This paper contains a valuable bibliography of publications relating to the climatology of Maryland.

The final report, by Mr. F. J. Walz, an *Outline of Present Knowledge of the Meteorology and Climatology of Maryland*, is a very complete account, containing full tables and many figures and charts. We note, with pleasure, a classification of Maryland weather into types, illustrated by means of weather maps, for climatology does not become a living study until the weather phenomena which go to make it up are understood. Mr. Walz has given us a climatic account of Maryland which is brought quite down to date, and which may well be adopted as a model by those who discuss the climates of other states. Excellent shaded charts showing precipitation and isotherms for each month, for the seasons, and for the year, accompany the report. Figures 35–40 are new. They are weather wind roses, and show the weather and wind conditions when Baltimore is under the influence of a cyclone and anticyclone in different seasons. Figure 55, the advent of spring in Maryland, is also an interesting addition to our knowledge of the climate of the state.

We have exceeded the limits which we set for this review at the outset, but we believe that the volume under discussion has been given no more space in this JOURNAL than it deserves. Paper, press-work and illustrations are all of the highest grade.

R. DEC. WARD.

HARVARD UNIVERSITY.

Indicators and Test Papers, their Source, Preparation, Application and Tests for Sensitiveness. By ALFRED I. COHN, PH.G. New York, John Wiley & Sons. 1899. Pp. 224.

As stated on the title page, this work is "a *résumé* of the current facts regarding the action and application of the indicators and test papers which have been proposed from time to time, and are in present use in chemical manipulations."

Part I. (pp. 19) deals with the general considerations determining the choice of indicators, their applications and limitations, behavior in other than aqueous solutions, dissociating effect of solvents, theory of their action, etc.

Part II. (pp. 154) is devoted to a discussion of a great number (76) of indicators, including not only those in common use, but also a great many others whose use has been recommended from time to time. The arrangement is alphabetical throughout, the data for each indicator being arranged under the following headings: Synonyms, Source, Preparation, Properties, and Application.

Part III. (pp. 51), on Test Papers, records the preparations and properties of 74 varieties, and is followed by tables showing the relative sensitiveness of indicators and test papers, and a

tabular summary of the behavior of the most important indicators toward the more common acids and bases.

On the whole, the book is likely to prove useful in the laboratory for reference, as it is carefully compiled and brings into a compact and systematized form a great mass of scattered detail. Although 75 per cent. of the indicators and test papers recorded would probably never be used by the average chemist, yet, in special cases, where the ordinary indicators fail, it may prove a great convenience to have at hand such a compilation from which a suitable one may be selected. The educational value of the book, however, might in many cases be increased by the use of graphic formulas, especially in several of the syntheses which the author represents merely by equations.

The book is of a convenient size and attractive in form, the subject-matter is well arranged, printed on good paper with very clear type, but the proof-reading has been only fairly well done.

M. T. B.

Zur Analyse der Unterschiedsempfindlichkeit. By LILLIE J. MARTIN und G. E. MÜLLER. Leipzig, J. A. Barth. 1899. Pp. vii + 233. M. 7.50.

It is a psychological sign of the times that this work on the perception of weight does not in the least concern itself with Weber's law, but leaves that issue entirely aside in order to consider the psychological and physiological elements in the process. Instead of looking for the bare statistical result of a large number of judgments, it asks *how* a judgment is carried out. Accepting as a fundamental answer the theory of Müller and Schumann—according to which the process consists in lifting with equal muscular force the two objects to be compared, and inferring their relative weights from their resulting movements—accepting this theory without serious discussion, the authors seek for minor factors in the process. Their method is two-fold: to collect introspective observations made during the experiments, and to vary the conditions and contrast the statistical results. By these methods they have detected the following factors:

First, fatigue and its opposite, namely, excitation or 'Bahnung.' It may happen that lifting the first of a pair of weights fatigues the motor centers; if so the energy of the second lift will involuntarily be less than that of the first, and the second weight will seem heavier than it is. In other conditions of the neuro-muscular system, lifting the first weight does not fatigue but stimulates; the second lift is then more energetic than the first, and the second weight feels correspondingly lighter. This theory—for it is not so well established as the other points made by the authors—is advanced in explanation of the 'time-error.'

Many judgments, though purporting to consist in the comparison of two given weights, were found to be something quite different. Often they were based on 'side-comparisons.' The actual comparison was not between the two weights given to be compared, but between one of them and the corresponding weight of the preceding pair. Though this seems an indirect and far-fetched manner of judging, it is often more readily adopted than the direct comparison. And in other cases no genuine comparison at all takes place, but the judgment is based on an *impression of the absolute weight* of one of the lifted objects. After growing accustomed to the series of weights used in an experiment and getting one's movements adjusted to the average run of those weights, one often finds that a weight on being lifted feels light, or feels heavy. This feeling is not a definite comparison of the given weight with the average; it is a mere impression, yet often very reliable. The impression is stronger the more the given weight differs from the average; which means that the easiest and most confident and correct judgments are the most apt to be determined by the mere impression, and the least apt to be genuine comparisons. Practice by no means eliminates this way of judging; on the contrary, the best demonstrated effect of practice was to increase the dependence on these impressions.

The impression of absolute weight operates differently in two classes of persons. Those of strong muscles and energetic movements are more subject to the impression of lightness; the less energetic to the impression of heaviness.

A large part of the monograph is occupied with an attempt to follow in detail the combined

effect of these various factors. This is a sort of quantitative analysis, which, though of purely technical interest, would have its value for psychology, could we but be sure of our numerical basis. When unfortunately there are, as in the present instance, three or more variable factors at our disposal, no one of which is a determined function of any other quantity, the field for arbitrary assumption of values is so wide that we have no means of checking our computation.

The real value of the work is that it points out several incidental factors in the process of judging. The more closely actual judgments are studied, the more evident does it become that they do not proceed according to the clean logical schemes which we are prone to devise for them in advance.

R. S. WOODWORTH.

GENERAL.

THE American Museum of Natural History, New York City, proposes to publish a selection of photographs collected by members of the Jesup North Pacific Expedition, provided a sufficient number of subscriptions can be obtained to warrant the undertaking. The photographs are to be reproduced by the heliotype process, in large quarto form. The edition will be limited to 250 copies. It is intended to issue the album in parts of at least 24 plates annually, the whole series to embrace 120 plates. It is contemplated to publish during the first year a series illustrating Indian types from the interior of British Columbia.

THE University of the State of New York has issued Museum Bulletin 24, supplementing the report of the entomologist for 1898, which is a memorial of the life and entomological work of Dr. Lintner. This contains a consolidated index to his whole series of reports and gives a nearly, if not quite, complete list of his scientific contributions during a long series of years. This volume of 316 pages will be sent postpaid to any address for 35 cents. Bulletin 28 is a pamphlet of 202 pages on the plants of North Elba, which will be much appreciated by the frequenters of that beautiful region. Its price postpaid is 20 cents. In University Handbook 16, the State Entomologist explains the scope and public utility of his field of work. This series of handbooks gives in convenient form information frequently called for regarding the various divisions of the university work, and single copies are mailed free to any address.

BOOKS RECEIVED.

The Nervous System and its Constituent Neurones. LEWELLYS F. BARKER. New York, D. Appleton & Co. 1899. Pp. xxxii + 1122.

Chemistry, its Evolution and Achievements. FERDINAND G. WIECHMANN. New York, Jenkins. 1899. Pp. vii + 176.

The Family of the Sun, Conversations with a Child. EDWARD S. HOLDEN. New York, D. Appleton & Co. 1899. Pp. xxiv + 252. 50c.

Handbook of Practical Hygiene. D. H. BERGEY. Easton, Pa., The Chemical Publishing Co. 1899. Pp. 164.

NOTES ON INORGANIC CHEMISTRY.

THE larger works on descriptive chemistry are full of compounds whose existence is doubtful, and it becomes the sometimes thankless task of the chemists of to-day to go over this old work and verify or prove false the work of earlier observers. An instance of this appears in the last *Journal* of the Chemical Society (London) in the case of the suboxid of phosphorus P_4O. The existence of such a compound, discovered by Le Verrier in 1838 was, indeed, called in question by von Schrötter in 1852, as he considered it merely an impure form of the red ('amorphous') phosphorus, which had not long before been discovered by him. In 1880, however, Goldschmidt and Reinitzer prepared a red substance which resembled Le Verrier's 'suboxid' and the existence of P_4O seemed to be confirmed. But now Chapman and Lidbury have gone over the whole subject, have prepared and analyzed every substance which has been described by different observers as 'suboxid' and come to the conclusion that the supposed suboxid P_4O is identical with red phosphorus in a finally divided and superficially somewhat oxidized and hydrated condition. No compound of definite composition could be found.

THE problem of softening hard waters for industrial purposes is one of the great problems of applied chemistry. Such softening is not merely necessary for boiler waters, but it has

been shown recently that the saving in excess of soap consumed by a hard water will render it economical for a city to expend a considerable sum in softening a hard water supply. In a recent number of the *Journal* of the American Chemical Society, M. L. Griffin gives the details of a series of experiments in the use of several softening agents. Waters containing less than .025 grams lime and .007 grams magnesia cannot be appreciably purified, though harder waters can often be reduced below these figures by purification. Calcium carbonate is most effectively removed by sodium hydroxid, sodium fluorid, and in some cases sodium aluminate. Calcium sulfate and chlorid are best treated with sodium fluorid, which, however, has no effect on magnesium salts. Sodium hydroxid is the most useful reagent for magnesium salts, and barium hydroxid follows, but the latter is not satisfactory for waters containing a large proportion of calcium carbonate and sulfate.

In the *Journal* of the Russian Chemical Society a new cerium mineral from the Caucasus is described by G. Tschernik, which from the analysis seems to be essentially a titanate and zirconate of cerium. It contains a gas which is 90% a mixture of nitrogen and argon. The mineral contains but .03% uranium and no helium. The ash of a coal from Tkwibuli, which was chiefly calcium sulfate, with alumina and silica, and about 10% of ceria, lanthana and didymia, showed the presence of over 1% of helium.

The *Report* of the Australian Association for the Advancement of Science contains a description by Thomas Steel of a 'red rain' which fell over Melbourne and much of Victoria on December 27, 1896. The rain carried down an unusually heavy fall of dust of red color, which appeared on analysis to be an ordinary surface soil derived from volcanic rocks. Under the microscope the presence of diatoms, scales of lepidoptera, quartz and garnet were detected.

An instance of the use of liquid ammonia as a solvent is shown by C. Hugot in the *Comptes Rendus*, where the selenids of sodium and potassium are thus formed. A mixture of selenium with the alkali metal is treated with liquid ammonia. If the metal is in excess the insoluble selenid Na_2Se or K_2Se is formed while if the selenium predominates a polyselenid Na_2Se_4 or K_2Se_4 is formed, which is dissolved in the ammonia and is obtained on its evaporation. Contrary to the observation of Franklin and Krauss, Hugot finds that selenium itself is insoluble in liquid ammonia. J. L. H.

TECHNICAL UNIVERSITY DEGREES.

A letter, recently received from Ex-President Andrew D. White, our Minister to Berlin, relative to matters educational, mainly, tells of the festival on the 100th anniversary of the founding of the great technical college at Charlottenburg, Berlin. This celebration, with its processions, its speech-making by the Emperor and other notables, and the structure and decorations of the great college buildings, have been fully described by press correspondents; but it has not been stated, so far as has been observed, except in a brief note in Science, that the Emperor, while erecting this splendid institution into a national, technical, university, making its powers those of the academic universities and its director a '*Rector Magnificus*,' conferred also the special power of giving the degree '*Dr. Ing.*,' doctor of engineering, a degree already established in this country, in 1884, at the initiative of the writer, and very sparingly conferred, to date, by the Stevens Institute of Technology.

The event, both as being the occasion of the formal institution of a national technical university, and as giving formal and official recognition to a degree which gives claim to full standing of the profession of Archimedes and Leonardo and the Marquis of Worcester, beside those of Hippocrates and of Justinian, was one of unusual importance and significance. This movement has been a vitally important part of that systematic programme which has led to the industrial triumph of Germany, of which Dr. White says in this letter: "It is amazing to see how, in their way, the Germans have gone steadily on until they have established a wonderful system of manufacturers all over their country and an astonishing commercial connection, through fleets of great steamers going to all parts of the world."

R. H. Thurston.

LECTURES AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

THE following are the courses of lectures to be delivered at the Museum, during the present season:

A Saturday afternoon course by officers of the Museum to members, illustrated.

January 6th.—The Philippine Islands: Professor Albert S. Bickmore.

January 13th.—A Naturalist in Florida: Mr. Frank M. Chapman.

January 20th.—Results of the Third Season's Explorations for Dinosaurs in Wyoming: Professor H. F. Osborn.

January 27th.—A Hunt for Fossil Horses and Elephants in Texas: Dr. W. D. Matthew.

February 3d.—The Geology and Mineralogy of Greater New York: Dr. L. P. Gratacap.

February 10th.—The Yellowstone National Park: Dr. E. O. Hovey.

February 17th.—The Eskimo of Hudson Bay: Professor Franz Boas.

February 24th.—The Thompson Indians of British Columbia: Mr. Harlan I. Smith. (The Jesup North Pacific expedition.)

March 3d.—The Madu Indians of California: Dr. Roland B. Dixon. (The C. P. Huntington expedition.)

March 10th.—The Pre-historic Sculptures of Mexico and Central America, exhibited in the Anthropological Department of the Museum: Mr. M. H. Saville. (The Loubat collection.)

March 17th.—Pre-historic Ruins in New Mexico: Professor F. W. Putnam. (The Hyde expedition.)

A lecture on 'A Naturalist in Cuba,' by Mr. Frank M. Chapman, will be delivered under the auspices of the Linnæan Society, January 11th.

Two lectures will be given on January 18th and 25th under the auspices of the New York Mineralogical Club.

A course of four lectures, by Professor A. S. Bickmore, will be delivered on March 8th, 15th, 22d and 29th.

Two lectures will be given on April 5th and 12th, under the auspices of the New York Botanical Garden.

The Thursday evening course to members (illustrated) by Professor Bickmore is as follows:

Dec. 7th.—The Philippines, Manila and the Tagals.

Dec. 14th.—The Visayans and Sulus.

Dec. 21st.—The Hawaiian Islands, Honolulu.

Dec. 28th.—Kilenea and Haleakala.

The Columbia University lectures given in coöperation with the Museum, by G. W. James, are:

Dec. 2d.—Down the Canyons of the Colorado with Major Powell.

Dec. 9th.—Dynamic Geology of the Grand Canyon.

Dec. 16th.—The Pamtes Desert.

Dec. 23d.—The Mesas of Acoma, Zuni and Moki.

Dec. 30th.—The Canyons of the Cliff Dwellers. This course is continued by other lecturers every Saturday evening from January 6th until March 31st.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR SIMON NEWCOMB has been elected a correspondent of the 'Bureau des Longitudes,' Paris, and a foreign member of the Royal Society of Lombardy.

THE Council of the Royal Society has awarded the Copley Medal to Lord Rayleigh, F.R.S., for his contributions to physical science, and the Davy Medal to Mr. Edward Schunck, F.R.S., for his investigations on madder, indigo and chlorophyll.

DR. A. H. DOTY, health officer of New York City, has returned from Europe, after several weeks spent in studying sanitary systems employed abroad.

WE learn from the *Botanical Gazette* that the international scientific medal of the Academie Internationale de Geographie Botanique has been conferred upon Dr. N. M. Glatfelter, of St. Louis, for his work upon *Salix*, and upon Dr. Roscoe Pound, of Lincoln, Nebr., for his phytogeographical researches. Fifteen investigators in Europe have been similarly honored.

MR. SHELFORD BIDWELL, M.A., LL.B., Gonville and Caius College, Cambridge, has been approved by the General Board of Studies for the degree of doctor in science.

HERR F. K. GINZEL, of the Bureau of Com-

putation of the Berlin Observatory, has been appointed to a professorship.

The death is announced of Mr. Augustus Doerflinger, a well-known engineer, at Brooklyn, on November 24th, in his fifty-fifth year. He was a graduate of Cornell University, and in the service of the government had charge of the removal of Hell Gate in the Harbor of New York City, and other important engineering works.

Dr. Wilhelm Zenker, the physicist, died in Berlin, on October 21st, aged seventy years.

The botanist and philologist, Stephan Ladislaus Endlicher, who died in 1849, was buried along with his wife Cecilia in the Matzlemsdorfer Cemetery in Vienna. *Natural Science* quotes from a Vienna journal the statement that on the 21st of June, the bodies were removed to a worthier resting place near the main entrance to the central Friedhof. The Rector of the University, Professor J. Wiesner, and the Director of the Botanical Gardens, delivered short orations in praise of Endlicher's genius and the services which he rendered to botany, philology, and science in general.

A memorial of Professor Heinrich van Bamberger, formerly professor of medicine in the University of Vienna, was unveiled in the quadrangle of the University on October 29th. An address was delivered by Professor Neusser.

Dr. Berthold Laufer has returned to Yokohoma from his expedition to the Amoor river and Saghalin, undertaken for the Jesup North Pacific expedition of the American Museum of Natural History, after an absence of nearly two years.

Professor John Milne, of Newport, Isle of Wight, has reported as follows to the trustees of the Elizabeth Thompson Science Fund: On February 19, 1898, the trustees of the Elizabeth Thompson Science Fund assigned me a grant of $250 in aid of a seismic survey of the world. This was expended in purchasing a horizontal pendulum, which was shipped to the care of H. M.'s Consul-General, W. J. Kenny, in Hawaii. When Mr. Kenny left Honolulu in March, 1899, the instrument was handed to Professor Maxwell, who will work in conjunction with Professor Alexander and Professor Hosmer (principal of the government high school), and the latter, I understand, will kindly make arrangements for its installation. Professor George Davidson, chairman of a committee appointed by the council of the University of California to undertake seismic investigations, writes me that Mr. Bishop, of Honolulu, has promised a site for the instrument, and that Professor Alexander will see that it is placed in working order. It is hoped that by next year a series of records will have been obtained from this exceedingly important station. Copies of the report based upon these records should be sent to the secretary of the board of trustees of the Elizabeth Thompson Science Fund, Harvard Medical School, Boston, Mass., through the liberality of which body the Hawaiian station has been established.

The *Botanical Gazette* states that by the coöperation of a local mountain club, Dr. R. von Wettstein, the director of the Vienna Botanical Garden, has been enabled to establish a Biological Experiment Station in the Tyrolese Central Alps, near the 'Bremer Hütte' in the Geschnitzthal, at an elevation of 2,300 m. A room in the college has been fitted up for a laboratory. Research will be directed first to the production of species by direct adaptation.

It is reported in *Natural Science* that an Association has been formed of collectors for the purpose of exploring the local lepidopterous fauna of Hildesheim and vicinity, under the title of *Verein für Schmetterlingsfreunde*. Professor A. Radcliffe Grote of the Roemer Museum presides.

The first meeting of the 81st session of the Institution of Civil Engineers was held at its house, Great George-street, Westminster, London, on November 7th, when the new president, Sir Douglas Fox, took the chair and delivered his inaugural address. The speaker called attention to the fact that Great Britain is not holding its own in mechanical science, compared with the nations of the continent and with the United States, especially in the introduction of electricity for lighting, traction and transmission of power.

The first scientific meeting of the Zoological Society of London for the session 1899–1900

took place at its house, 3 Hanover Square, on Tuesday, November 14th.

A MEETING of the Fellows of the Royal Botanic Society was held in the museum at the Royal Botanic Gardens, Regent's Park, London, on November 11th, Major Cotton presiding. He stated that the number of Fellows elected this year had been greater than in any previous year since the foundation of the Society. He added that the club, which was founded at the beginning of the year, had been very successful, and the members, limited as they were to Fellows of the Society, now numbered over 600. The series of dinners that had taken place in the summer were so largely attended that many had had to be turned away, and steps were consequently being taken to increase the accommodation. In connection with the club dinners, entertainments were now being given every Wednesday evening and the Fellows were cordially invited.

DR. TIESSEN'S scientific notices state that a bacteriological institute has been established by the Russian government in Wladiwostok, East Asia, and that one is planned for Merw in Central Asia.

IT is reported that the Russian Astronomical Society has finally given up its attempt to revise the Julian calendar. The reason assigned for its failure by the Society is "the impossibility of establishing an agreement between the dates of the religious festivals appearing in both calendars."

ACTING SUPERINTENDENT WILCOX, of the Yosemite National Park, in his annual report, recommends that the government buy out the owners of patented lands within the park limits. Other recommendations are the fixing of penalties for violation of the park regulations; obtaining authority from the state of California to establish a camp for troops within the Yosemite valley for patrol purposes, a permanent camp to be constructed at Wawona; a systematic burning of fallen and dead timber, to prevent forest fires; and some decisive action to prevent diverting the waters flowing into the park. The report says the deer are fairly plentiful and tame, bear, quail, squirrels and trout are numerous, and mountain lions and lynx are to be found.

A PRESS despatch from Washington states that the War Department is at work on the problem of wireless telegraphy for the signal service. The Signal Corps has been handicapped recently both by lack of funds and officers to experiment on an extensive scale, but Capt. Reiber, at Governor's Island, New York, is carrying on a series of experiments between that point and Tompkinsville, with a view to adapting the army apparatus for communication between fortified points and in any other locations where the wireless system might prove superior in practice to the older form of telegraphy. The army is not dependent on Marconi for instruments, having developed a system of its own, and the work will be pushed with vigor when Congress furnishes the necessary means.

COMMENTING on the failure of the British Government to use wireless telegraphy in South Africa *Nature* says: Science, and especially the latest developments of science, are the last things to interest our government and the government departments; they do not believe in science, they care to know very little about it, and the scientific spirit is absent from too many of their plans and doings. Hence we have now to be thankful that they have reached the level of the pigeon post, which has been the only official means, and that on the part of one or two birds, to keep us in touch with our beleaguered forces. It is stated that even the Commander-in-Chief, Lord Wolseley, has expressed some surprise that the so-called 'Intelligence Department' of the army allowed the Ladysmith force to go to the front with mountain guns against a Boer force which they should have known might be armed with Schneider-Canet cannons of large calibre; and it would seem that probably a terrible disaster has been prevented, not by our Intelligence Department, not by the outfit of our army, but by the apparently accidental arrival of naval guns and *personnel* at the last moment. Why is there not a Scientific Committee to do what it can in advising the military authorities? If they could do nothing, nobody would be the worse, but they might be able to do much to the nation's advantage.

UNIVERSITY AND EDUCATIONAL NEWS.

A FRIEND of McGill University and of Sir William Dawson has communicated to the board of governors of the university his wish to endow a chair to be called the 'Dawson chair,' in memory of the late emeritus principal and eminent geologist, and has contributed money for that purpose, with the condition that Lady Dawson shall enjoy the income during her life.

THOMAS ARMSTRONG, of Plattsburgh, N. Y., who died in 1897, left his property amounting to $300,000 to Union College, Schenectady, N. Y. Suit was brought on behalf of his wife and children, and half of the estate has been awarded to them, while the remaining $150,000 goes to Union College.

VASSAR COLLEGE has recived a gift of $5,000 toward the proposed biological laboratory, for which $25,000 has been promised on condition that an equal additional sum shall be raised.

THE report of the treasurer of Yale University shows that its invested funds have increased during President Dwight's administration of thirteen years from a little over $2,000,000 to nearly $5,000,000. This does not include the endowment of the Sheffield Scientific School, which is about $600,000. The income from invested funds has increased from about $113,000 to about $221,000, while students' fees have increased still more rapidly, namely, from about $150,000 to about $500,000. The permanent funds of the University were increased last year by nearly $100,000 and the building fund by about the same amount.

AN influential meeting was held in the Senate house of Cambridge University on November 4th for the purpose of forming an association the objects of which are—(1) To establish and distribute information respecting appointments which can be appropriately filled by members of the association; (2) to establish and organize means of communication between candidates for such appointments and the persons or bodies making the appointments. Remarks were made by the Chancellor, by Lord Rothschild, and others. It was resolved "that an association be formed for facilitating the employment of graduates of the University in the various professions and occupations for which they are fitted by their university training," and a board of management was appointed. There are similar committees at Oxford University and at Harvard and Columbia Universities.

THE following past-list for the D.Sc., of the University of London, examination has been issued.

Mathematics. — John G. Leathem (Granville Scholarship), St. John's Coll., Cambridge.

Experimental Physics. — George B. Bryan, St. John's Coll., Cambridge, and Univ. Coll., Nottingham; Edgar W. Marchant (Granville Scholarship), Central Technical Coll., and pr. st.; Samuel R. Milner, Univ. Coll., Bristol, Inst. für Physik-Chemie, Göttingen, and Owens Coll.; Spencer W. Richardson, Trin. Coll., Cambridge, and Cavendish Laboratory.

Chemistry.—Martin O. Forster (Granville Scholarship), Royal Coll. of Science; Edwin C. Jee Central Technical Coll.; Thomas M. Lowry, Central Technical Coll.; Gilbert T. Morgan, Royal Coll. of Science; Robert H. Pickard, Mason Univ. Coll.

Botany.—Albert H. Trow, private study.

Employment of the Theory of Correlations in Biological and other Investigations.—Alice E. Lee, B.A., Univ. Coll.

Zoology.—James H. Ashworth, Owens Coll.; Ernest W. MacBride, Zoological Laboratory, Cambridge; Arthur T. Masterman, Christ's Coll., Cambridge, and St. And. Univ.

Geology.—Charles G. Cullis, Royal Coll. of Science.

DR. KARL W. GEUTHE has been appointed instructor in zoology in the University of Michigan.

AT St. John's College Cambridge, the following fellows have been elected: Mr. W. A. Houston, fifth wrangler, 1896, lecturer in mathematics in University College, Liverpool, and Mr. Grafton Elliott-Smith, assistant demonstrator of anatomy in the University, who has made valuable contributions to the comparative anatomy of the brain.

DR. C. CORRENS has been made assistant professor of botany in the University at Tübingen.

THE following have qualified as docents in German universities: Dr. Bohumil Neuseč in plant anatomy and physiology in the Bohemian University at Prague; Dr. Wederkind in natural science in the University at Tübingen, and Dr. Dandler for anatomy in the University at Vienna.

SCIENCE

FRIDAY, DECEMBER 8, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE HIGHEST AIM OF THE PHYSICIST.*

GENTLEMEN AND FELLOW PHYSICISTS OF AMERICA: We meet to day on an occasion which marks an epoch in the history of physics in America; may the future show that it also marks an epoch in the history of the science which this Society is organized to cultivate! For we meet here in the interest of a science which above all sciences deals with the foundation of the Universe, with the constitution of matter from which everything in the Universe is made and with the ether of space by which alone the various portions of matter forming the Universe affect each other even at such distances as we may never expect to traverse, whatever the progress of our science in the future.

We, who have devoted our lives to the solution of problems connected with physics, now meet together to help each other and to forward the interests of the subject which we love. A subject which appeals most strongly to the better instincts of our nature and the problems of which tax our minds to the limit of their capacity and suggest the grandest and noblest ideas of which they are capable.

In a country where the doctrine of the equal rights of man has been distorted to mean the equality of man in other respects,

* Address delivered to the Physical Society of America by the President, at its meeting in New York, October 28, 1899.

we form a small and unique body of men, a new variety of the human race as one of our greatest scientists calls it, whose views of what constitutes the greatest achievement in life are very different from those around us. In this respect we form an aristocracy, not of wealth, not of pedigree, but of intellect and of ideals, holding him in the highest respect who adds the most to our knowledge or who strives after it as the highest good.

Thus we meet together for mutual sympathy and the interchange of knowledge, and may we do so ever with appreciation of the benefits to ourselves and possibly to our science. Above all, let us cultivate the idea of the dignity of our pursuit so that this feeling may sustain us in the midst of a world which gives its highest praise, not to the investigation in the pure etherial physics which our Society is formed to cultivate, but to one who uses it for satisfying the physical rather than the intellectual needs of mankind. He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely worked to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.

How stands our country, then, in this respect? My answer must still be, now, as it was fifteen years ago, that much of the intellect of the country is still wasted in the pursuit of so-called practical science which ministers to our physical needs and but little thought and money is given to the grander portion of the subject which appeals to our intellect alone. But your presence here gives evidence that such a condition is not to last forever.

Even in the past we have a few names whom scientists throughout the world delight to honor. Franklin, who almost revolutionized the science of electricity by a few simple but profound experiments. Count Rumford, whose experiments almost demonstrated the nature of heat. Henry, who might have done much for the progress of physics had he published more fully the results of his investigations. Mayer, whose simple and ingenious experiments have been a source of pleasure and profit to many. This is the meager list of those whom death allows me to speak of and who have earned mention here by doing something for the progress of our science. And yet the record has been searched for more than a hundred years. How different had I started to record those who have made useful and beneficial inventions!

But I know, when I look in the faces of those before me, where the eager intellect and high purpose sit enthroned on bodies possessing the vigor and strength of youth, that the writer of a hundred years hence can no longer throw such a reproach upon our country. Nor can we blame those who have gone before us. The progress of every science shows us the condition of its growth. Very few persons, if isolated in a semi-civilized land, have either the desire or the opportunity of pursuing the higher branches of science. Even if they should be able to do so, their influence on their science depends upon what they publish and make known to the world. A hermit philosopher we can imagine might make many useful discoveries. Yet, if he keeps them to himself, he can never claim to have benefited the world in any degree. His unpublished results are his private gain, but the world is no better off until he has made them known in language strong enough to call attention to them and to convince the world of their truth. Thus, to encourage the growth of any science, the best thing we can do is to meet together in its interest, to discuss its problems, to criticize each other's work and, best of all, to provide means by which the better portion of it may be made known to the world. Furthermore, let us encourage discrimination in our thoughts

and work. Let us recognize the eras when great thoughts have been introduced into our subject and let us honor the great men who introduced and proved them correct. Let us forever reject such foolish ideas as the equality of mankind and carefully give the greater credit to the greater man. So, in choosing the subjects for our investigation, let us, if possible, work upon those subjects which will finally give us an advanced knowledge of some great subject. I am aware that we cannot always do this ; our ideas will often flow in side channels; but, with the great problems of the Universe before us, we may sometime be able to do our share toward the greater end.

What is matter; what is gravitation; what is ether and the radiation through it; what is electricity and magnetism ; how are these connected together and what is their relation to heat? These are the greater problems of the universe. But many infinitely smaller problems we must attack and solve before we can even guess at the solution of the greater ones.

In our attitude toward these greater problems how do we stand and what is the foundation of our knowledge?

Newton and the great array of astronomers who have succeeded him have proved that, within planetary distances, matter attracts all others with a force varying inversely as the square of the distance. But what sort of proof have we of this law? It is derived from astronomical observations on the planetary orbits. It agrees very well within these immense spaces; but where is the evidence that the law holds for smaller distances? We measure the lunar distance and the size of the earth and compare the force at that distance with the force of gravitation on the earth's surface. But to do this we must compare the matter in the earth with that in the sun. This we can only do by *assuming* the law to be proved. Again, in descending from the earth's gravitation to that of two small bodies, as in the Cavendish experiment, we *assume* the law to hold and deduce the mass of the earth in terms of our unit of mass. Hence, when we say that the mass of the earth is $5\frac{1}{2}$ times that of an equal volume of water we *assume* the law of gravitation to be that of Newton. Thus a proof of the law from planetary down to terrestrial distances is physically impossible.

Again, that portion of the law which says that gravitational attraction is proportional to the quantity of matter, which is the same as saying that the attraction of one body by another is not affected by the presence of a third, the feeble proof that we give by weighing bodies in a balance in different positions with respect to each other cannot be accepted on a larger scale. When we can tear the sun into two portions and prove that either of the two halves attracts half as much as the whole, then we shall have a proof worth mentioning.

Then as to the relation of gravitation and time what can we say? Can we for a moment suppose that two bodies moving through space with great velocities have their gravitation unaltered? I think not. Neither can we accept Laplace's proof that the force of gravitation acts instantaneously through space, for we can readily imagine some compensating features unthought of by Laplace.

How little we know then of this law which has been under observation for two hundred years!

Then as to matter itself how have our views changed and how are they constantly changing. The round hard atom of Newton which God alone could break into pieces has become a molecule composed of many atoms, and each of these smaller atoms has become so elastic that after vibrating 100,000 times its amplitude of vibration is scarcely diminished. It has become so complicated that it can vibrate

with as many thousand notes. We cover the atom with patches of electricity here and there and make of it a system compared with which the planetary system, nay the universe itself, is simplicity. Nay more: some of us even claim the power, which Newton attributed to God alone, of breaking the atom into smaller pieces whose size is left to the imagination. Where, then, is that person who ignorantly sneers at the study of matter as a material and gross study? Where, again, is that man with gifts so God-like and mind so elevated that he can attack and solve its problem?

To all matter we attribute two properties, gravitation and inertia. Without these two matter cannot exist. The greatest of the natural laws states that the power of gravitational attraction is proportional to the mass of the body. This law of Newton, almost neglected in the thoughts of physicists, undoubtedly has vast import of the very deepest meaning. Shall it mean that all matter is finally constructed of uniform and similar primordial atoms or can we find some other explanation?

That the molecules of matter are not round, we know from the facts of crystallography and the action of matter in rotating the plane of polarization of light.

That portions of the molecules and even of the atoms are electrically charged, we know from electrolysis, the action of gases in a vacuum tube and from the Zeeman effect.

That some of them act like little magnets, we know from the magnetic action of iron, nickel and cobalt.

That they are elastic, the spectrum shows, and that the vibrating portion carries the electrified charge with it is shown by the Zeeman effect.

Here, then, we have made quite a start in our problem: but how far are we from the complete solution? How can we imagine the material of which ordinary or primordial atoms are made, dealing as we do only with aggregation of atoms alone? Forever beyond our sight, vibrating an almost infinite number of times in a second, moving hither and yon with restless energy at all temperatures beyond the absolute zero of temperature, it is certainly a wonderful feat of human reason and imagination that we know as much as we do at present. Encouraged by these results, let us not linger too long in their contemplation but press forward to the new discoveries which await us in the future.

Then as to electricity, the subtile spirit of the amber, the demon who reached out his gluttonous arms to draw in the light bodies within his reach, the fluid which could run through metals with the greatest ease but could be stopped by a frail piece of glass! Where is it now? Vanished, thrown on the waste heap of our discarded theories to be replaced by a far nobler and exalted one of action in the ether of space.

And so we are brought to consider that other great entity—the ether: filling all space without limit, we imagine the ether to be the only means by which two portions of matter distant from each other can have any mutual action. By its means we imagine every atom in the universe to be bound to every other atom by the force of gravitation and often by the force of magnetic and electric action, and we conceive that it alone conveys the vibratory motion of each atom or molecule out into space to be ever lost in endless radiation, passing out into infinite space or absorbed by some other atoms which happen to be in its path. By it all electromagnetic energy is conveyed from the feeble attraction of the rubbed amber through the many thousand horse-power conveyed by the electric wires from Niagara to the mighty rush of energy always flowing from the Sun in a flood of radiation. Actions feeble and actions mighty from inter-

molecular distances through interplanetary and interstellar distances until we reach the mighty distances which bound the Universe—all have their being in this wondrous ether.

And yet, however wonderful it may be, its laws are far more simple than those of matter. Every wave in it, whatever its length or intensity, proceeds onwards in it according to well known laws, all with the same speed, unaltered in direction from its source in electrified matter, to the confines of the Universe unimpaired in energy unless it is disturbed by the presence of matter. However the waves may cross each other, each proceeds by itself without interference with the others.

So with regard to gravitation, we have no evidence that the presence of a third body affects the mutual attraction of two other bodies, or that the presence of a third quantity of electricity affects the mutual attraction of two other quantities. The same for magnetism.

For this reason the laws of gravitation and of electric and magnetic action including radiation are the simplest of all laws when we confine them to a so-called vacuum, but become more and more complicated when we treat of them in space containing matter.

Subject the ether to immense electrostatic, magnetic or gravitational forces and we find absolutely no signs of its breaking down or even of change of properties. Set it into vibration by means of an intensely hot body like the sun and it conveys many thousand horse-power for each square foot of surface as quietly and with apparently unchanged laws as if it were conveying the energy of a tallow dip.

Again, subject a millimeter of ether to the stress of many thousand, nay even a million, volts and yet we see no signs of breaking down.

Hence the properties of the ether are of ideal simplicity and lead to the simplest of natural laws. All forces which act at a distance, always obey the law of the inverse square of the distance, and we have also the attraction of any number of parts placed near each other equal to the arithmetical sum of the attractions when those parts are separated. So also the simpler law of etherial waves which has been mentioned above.

At the present time, through the labors of Maxwell supplemented by those of Hertz and others, we have arrived at the great generalization that all wave disturbances in the ether are electromagnetic in their nature. We know of little or no etherial disturbance which can be set up by the motion of matter alone: the matter must be electrified in order to have sufficient hold on the ether to communicate its motion to the ether. The Zeeman effect even shows this to be the case where molecules are concerned and when the period of vibration is immensely great. Indeed the experiment on the magnetic action of electric convection shows the same thing. By electrifying a disc in motion it appears as if the disc holds fast to the ether and drags it with it, thus setting up the peculiar etherial motion known as magnetism.

Have we not another case of a similar nature when a huge gravitational mass like that of the earth revolves on its axis? Has not matter a feeble hold on the ether sufficient to produce the earth's magnetism?

But the experiment of Lodge to detect such an action apparently showed that it must be very feeble. Might not his experiment have succeeded had he used an electrical revolving disc?

To detect something dependent on the relative motion of the ether and matter has been and is the great desire of physicists. But we always find that, with one possible exception, there is always some compensating feature which renders our efforts use-

less. This one experiment is the aberration of light, but even here Stokes has shown that it may be explained in either of two ways: first, that the earth moves through the ether of space without disturbing it, and second, if it carries the ether with it by a kind of motion called irrotational. Even here, however, the amount of action probably depends upon *relative* motion of the luminous source to the recipient telescope.

So the principle of Döppler depends also on this relative motion and is independent of the ether.

The result of the experiments of Foucault on the passage of light through moving water can no longer be interpreted as due to the partial movement of the ether with the moving water, an inference due to imperfect theory alone. The experiment of Lodge, who attempted to set the ether in motion by a rapidly rotating disc, showed no such result.

The experiment of Michelson to detect the etherial wind, although carried to the extreme of accuracy, also failed to detect any relative motion of the matter and the ether.

But matter with an electrical charge holds fast to the ether and moves it in the manner required for magnetic action.

When electrified bodies move together through space or with reference to each other we can only follow their mutual actions through very slow and uniform velocities. When they move with velocities comparable with that of light, equal to it or even beyond it, we calculate their mutual actions or action on the ether only by the light of our imagination unguided by experiment. The conclusions of J. J. Thomson, Heaviside and Hertz are all results of the imagination and they all rest upon assumptions more or less reasonable but always assumptions. A mathematical investigation always obeys the law of the conservation of knowledge: we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated, but the total amount of the knowledge of nature given out by the investigation is the same as we started with. Hence we can never predict the result in the case of velocities beyond our reach, and such calculations as the velocity of the cathode rays from their electromagnetic action has a great element of uncertainty which we should do well to remember.

Indeed, when it comes to exact knowledge, the limits are far more circumscribed.

How is it, then, that we hear physicists and others constantly stating what will happen beyond these limits? Take velocities, for instance, such as that of a material body moving with the velocity of light. There is no known process by which such a velocity can be obtained even though the body fell from an infinite distance upon the largest aggregation of matter in the Universe. If we electrify it, as in the cathode rays, its properties are so changed that the matter properties are completely masked by the electromagnetic.

It is a common error which young physicists are apt to fall into to obtain a law, a curve or a mathematical expression for given experimental limits and then to apply it to points outside those limits. This is sometimes called extrapolation. Such a process, unless carefully guarded, ceases to be a reasoning process and becomes one of pure imagination specially liable to error when the distance is too great.

But it is not my purpose to enter into detail. What I have given suffices to show how little we know of the profounder questions involved in our subject.

It is a curious fact that, having minds tending to the infinite, with imaginations unlimited by time and space, the limits of our exact knowledge are very small indeed.

In time we are limited by a few hundred or possibly thousand years: indeed the limit in our science is far less than the smaller of these periods. In space we have exact knowledge limited to portions of our earth's surface and a mile or so below the surface, together with what little we can learn from looking through powerful telescopes into the space beyond. In temperature our knowledge extends from near the absolute zero to that of the sun but exact knowledge is far more limited. In pressures we go from the Crookes vacuum still containing myriads of flying atoms to pressures limited by the strength of steel but still very minute compared with the pressures at the center of the earth and sun, where the hardest steel would flow like the most limpid water. In velocities we are limited to a few miles per second. In forces to possibly 100 tons to the square inch. In mechanical rotations to a few hundred times per second.

All the facts which we have considered, the liability to error in whatever direction we go, the infirmity of our minds in their reasoning power, the fallibility of witnesses and experimenters, lead the scientist to be specially sceptical with reference to any statement made to him or any so-called knowledge which may be brought to his attention. The facts and theories of our science are so much more certain than those of history, of the testimony of ordinary people on which the facts of ordinary history or of legal evidence rest, or of the value of medicines to which we trust when we are ill, indeed to the whole fabric of supposed truth by which an ordinary person guides his belief and the actions of his life, that it may seem ominous and strange if what I have said of the imperfections of the knowledge of physics is correct. How shall we regulate our minds with respect to it: there is only one way that I know of and that is to avoid the discontinuity of the ordinary, indeed the so-called cultivated legal mind. There is no such thing as absolute truth and absolute falsehood. The scientific mind should never recognize the perfect truth or the perfect falsehood of any supposed theory or observation. It should carefully weigh the chances of truth and error and grade each in its proper position along the line joining absolute truth and absolute error.

The ordinary crude mind has only two compartments, one for truth and one for error; indeed the contents of the two compartments are sadly mixed in most cases: the ideal scientific mind, however, has an infinite number. Each theory or law is in its proper compartment indicating the probability of its truth. As a new fact arrives the scientist changes it from one compartment to another so as, if possible, to always keep it in its proper relation to truth and error. Thus the fluid nature of electricity was once in a compartment near the truth. Faraday's and Maxwell's researches have now caused us to move it to a compartment nearly up to that of absolute error.

So the law of gravitation within planetary distances is far toward absolute truth, but may still need amending before it is advanced farther in that direction.

The ideal scientific mind, therefore, must always be held in a state of balance which the slightest new evidence may change in one direction or another. It is in a constant state of skepticism, knowing full well that nothing is certain. It is above all an agnostic with respect to all facts and theories of science as well as to all other so-called beliefs and theories.

Yet it would be folly to reason from this that we need not guide our life according to the approach to knowledge that we possess. Nature is inexorable; it punishes the child who unknowingly steps off a precipice quite as severely as the grown scientist who steps over, with full knowledge of all the

laws of falling bodies and the chances of their being correct. Both fall to the bottom and in their fall obey the gravitational laws of inorganic matter, slightly modified by the muscular contortions of the falling object but not in any degree changed by the previous belief of the person. Natural laws there probably are, rigid and unchanging ones at that. Understand them and they are beneficent: we can use them for our purposes and make them the slaves of our desires. Misunderstand them and they are monsters who may grind us to powder or crush us in the dust. Nothing is asked of us as to our belief: they act unswervingly and we must understand them or suffer the consequences. Our only course, then, is to act according to the chances of our knowing the right laws. If we act correctly, right; if we act incorrectly, we suffer. If we are ignorant we die. What greater fool, then, than he who states that belief is of no consequence provided it is sincere.

An only child, a beloved wife, lies on a bed of illness. The physician says that the disease is mortal; a minute plant called a microbe has obtained entrance into the body and is growing at the expense of its tissues, forming deadly poisons in the blood or destroying some vital organ. The physician looks on without being able to do anything. Daily he comes and notes the failing strength of his patient and daily the patient goes downward until he rests in his grave. But why has the physician allowed this? Can we doubt that there is a remedy which shall kill the microbe or neutralize its poison? Why, then, has he not used it? He is employed to cure but has failed. His bill we cheerfully pay because he has done his best and given a chance of cure. The answer is *ignorance*. The remedy is yet unknown. The physician is waiting for others to discover it or perhaps is experimenting in a crude and unscientific manner to find it. Is not the inference correct, then, that the world has been paying the wrong class of men? Would not this ignorance have been dispelled had the proper money been used in the past to dispel it? Such deaths some people consider an act of God. What blasphemy to attribute to God that which is due to our own and our ancestors' selfishness in not founding institutions for medical research in sufficient number and with sufficient means to discover the truth. Such deaths are murder. Thus the present generation suffers for the sins of the past and we die because our ancestors dissipated their wealth in armies and navies, in the foolish pomp and circumstance of society, and neglected to provide us with a knowledge of natural laws. In this sense they were the murderers and robbers of future generations of unborn millions and have made the world a charnel house and place of mourning where peace and happiness might have been. Only their ignorance of what they were doing can be their excuse, but this excuse puts them in the class of boors and savages who act according to selfish desire and not to reason and to the calls of duty. Let the present generation take warning that this reproach be not cast on it, for it cannot plead ignorance in this respect.

This illustration from the department of medicine I have given because it appeals to all. But all the sciences are linked together and must advance in concert. The human body is a chemical and physical problem, and these sciences must advance before we can conquer disease.

But the true lover of physics needs no such spur to his actions. The cure of disease is a very important object and nothing can be nobler than a life devoted to its cure.

The aims of the physicist, however, are in part purely intellectual; he strives to understand the Universe on account of the intellectual pleasure derived from the pursuit, but he is upheld in it by the knowl-

edge that the study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race.

Where, then, are the greatest laboratories of research in this city, in this country, nay, in the world? We see a few miserable structures here and there occupied by a few starving professors who are nobly striving to do the best with the feeble means at their disposal. But where in the world is the institute of pure research in any department of science with an income of $100,000,000 per year. Where can the discoverer in pure science earn more than the wages of a day laborer or cook? But $100,000,000 per year is but the price of an army or a navy designed to kill other people. Just think of it, that one per cent. of this sum seems to most people too great to save our children and descendants from misery and even death!

But the twentieth century is near—may we not hope for better things before its end? May we not not hope to influence the public in this direction?

Let us go forward, then, with confidence in the dignity of our pursuit. Let us hold our heads high with a pure conscience while we seek the truth, and may the American Physical Society do its share now and in generations yet to come in trying to unravel the great problem of the constitution and laws of the Universe.

HENRY A. ROWLAND.

CRUISE OF THE ALBATROSS.

THE following letter has been received by the U. S. Fish Commission from Professor Alexander Agassiz. It is dated Papeete Harbor, Tahiti Island, September 30, 1899, and gives an account of the voyage of the *Albatross* up to that time.

I arrived at San Francisco on August 20th, and after consulting with Commander Moser we decided to leave on Wednesday, the 23d. Everything shipped from the east had arrived with the exception of the tow nets sent me by Dr. Kramer, and the deep-sea nets kindly ordered for me by Professor Chun of Leipzig. Captain Moser and I decided not to make any soundings nor do any deep-sea work until we had passed beyond the lines of soundings already run by the *Albatross* and *Thetis* between California and the Hawaiian Islands.

In latitude 31° 10′ N., and longitude 125° W., we made our first sounding in 1955 fathoms, about 320 miles from Point Conception, the nearest land. We occupied 26 stations until we reached the northern edge of the plateau from which rise the Marquesas Islands, having run from station No. 1, a distance of 3800 miles, in a straight line.

At station No. 2 the depth had increased to 2368 fathoms, the nearest land, Guadeloupe Island, being about 450 miles, and Point Conception nearly 500 miles distant. The depth gradually increased to 2628, 2740, 2810, 2881, 3003, and 3088 fathoms, the last in lat. 16° 38′ N., long. 130 14′ W., the deepest sounding we obtained thus far in the unexplored part of the Pacific through which we are passing. From that point the depths varied from 2883 to 2690 and 2776, diminishing to 2583, and gradually passing to 2440, 2463, and 2475 fathoms, until off the Marquesas, in lat. 7° 58′ S., long. 139° 08′ W., the depth became 2287 fathoms. It then passed to 1929, 1802, and 1040 fathoms, in lat. 8° 41′ S., long. 139° 46′ W., Nukuhiva Island being about 30 miles distant. Between Nukuhiva and Houa-Houna (Ua-Huka) islands we obtained 830 fathoms, and 5 miles south of Nukuhiva 687 fathoms. When leaving Nukuhiva for the Paumotus we sounded in 1284 fathoms about 9 miles south of that island. These soundings seem to show that this part of the Marquesas rises from a

plateau having a depth of 2000 fathoms, and about 50 miles in width, as at station No. 29 we obtained 1932 fathoms.

Between the Marquesas and the northwestern extremity of the Paumotus we occupied 9 stations, the greatest depth on that line being at station No. 31, in lat. 12° 20′ S., and long. 144° 15′ W. The depths varied between 2451 and 2527 fathoms, and diminished to 1208 fathoms off the west end of Ahii, and then to 706 fathoms when about 16 miles N. E. of Avatoru Pass in Rairoa Island.

We developed to a certain extent the width of the Paumotu group plateau by a line of soundings in continuation of the direction of Avatoru Pass, extending a little less than 9 miles seaward where we obtained a depth of 819 fathoms. Subsequently we ran a similar line normal to the south shore of the lagoon of Rairoa a distance of nearly 12 miles into 897 fathoms.

Between Rairoa and Tikehau, the next island to the westward, we got a depth of 1486 fathoms.

Between Tikehau and Mataiwa 6 soundings were made with a depth of 488 fathoms half a mile from shore, and a greatest depth of 850 fathoms 6½ miles from Tikehau. The slope approaching Mataiwa is steeper than the Tikehau slope.

From Mataiwa to Makatea (Aurora) Island, we made 6 soundings: from 642 fathoms about 2½ miles off shore, to 581 fathoms about 1½ miles off the west side of the latter island, the depths passing to 860, 1257, 1762, and the greatest depth being 2267 fathoms; then 2243, and rising more rapidly near Makatea to 851 fathoms.

Between Makatea and Tahiti we made 8 soundings, beginning with 1363 fathoms, 2 miles off the southern end of Makatea, passing to 2238, 2363 (the greatest depth on that line), 2224, 1930, 1585, 775, and finally 867 fathoms off Point Venus.

These make in all 72 soundings up to the present time.

The deep basin developed by our soundings between lat. 24° 30′ N., and lat. 6° 25′ S., varying in depth from nearly 3100 fathoms to a little less than 2500 fathoms, is probably the western extension of a deep basin indicated by two soundings on the charts, to the eastward of our line, in longitudes 125° and 120° W., and latitudes 9° and 11° N., one of over 3100 fathoms, the other of more than 2550 fathoms, showing this part of the Pacific to be of considerable depth, and to form a uniformly deep basin of great extent, continuing westward probably, judging from the soundings, for a long distance.

I would propose, in accordance with the practice adopted for naming such well-defined basins of the ocean, that this large depression of the Central Pacific, extending for nearly 30° of latitude, be named Moser Basin.

The character of the bottom of this basin is most interesting. The haul of the trawl made at station No. 2, lat. 28° 23′ N., long. 126° 57′ W., brought up the bag full of red clay and manganese nodules with sharks' teeth and cetacean ear-bones; and at nearly all our stations we had indications of manganese nodules. At station No. 13, in 2690 fathoms, lat. 9° 57′ N., long. 137° 47′ W., we again obtained a fine trawl haul of manganese nodules and red clay; there must have been at least enough to fill a 40-gallon barrel.

The nodules of our first haul were either slabs from 6 to 18 inches in length and 4 to 6 inches in thickness, or small nodules ranging in size from that of a walnut to a lentil or less; while those brought up at station No. 13 consisted mainly of nodules looking like mammillated cannon balls varying from 4½ to 6 inches in diameter, the largest being 6½ inches. We again brought up manganese nodules at the Equa-

tor in about longitude 138° W., and subsequently—until within sight of Tahiti—we occasionally got manganese nodules.

As had been noticed by Sir John Murray in the *Challenger*, these manganese nodules occur in a part of the Pacific most distant from continental areas. Our experience has been similar to that of the *Challenger*, only I am inclined to think that these nodules range over a far greater area of the Central Pacific than had been supposed, and that this peculiar manganese-nodule bottom characterizes a great portion of the deep parts of the Central Pacific where it cannot be affected by the deposit of globigerina, pteropods, or telluric ooze; in the region characterized also by red-clay deposits. For in the track of the great equatorial currents there occur deposits of globigerina ooze in over 2400 fathoms for a distance of over 300 miles in latitude.

Manganese nodules we found south of the Marquesas also, where in 2700 fathoms we obtained, perhaps, the finest specimens of red clay from any of our soundings. As we approached close to the western Paumotus, and rose upon the plateau from which they rise, globigerina ooze passed gradually to pteropod ooze, then to fine and coarse coral sand. In the channel south of the Paumotus to Tahiti the coral sand passed to volcanic sand mixed with globigerinæ in the deepest parts of the line, and toward Tahiti passed to volcanic mud mixed with globigerinæ, next to fine volcanic sand, and finally, at the last sounding, off Point Venus, to coarse volcanic sand.

We made a few hauls of the trawl on our way, but owing to the great distance we had to steam between San Francisco and the Marquesas (3800 miles) we could not, of course, spend a great deal of time either in trawling or in making tows at intermediate depths. Still the hauls we made with the trawl were most interesting, and confirmed what other deep-sea expeditions have realized: that at great depths, at considerable distances from land and away from any great oceanic current, there is comparatively little animal life to be found. Where manganese nodules were found the hauls were specially poor, a few deep-sea holothurians and ophiurans, and some small actiniæ which had attached themselves to the nodules with a few other invertebrates, seemed to be all that lived at these great depths, 2500 to 2900 fathoms, far away—say from 700 to 1000 miles—from the nearest land.

The bottom temperatures of the deep (Moser) basin varied between 34.6° at 2628 and 2740 fathoms, to 35.2° at 2440 fathoms, and 35° at 2475 fathoms; about 120 miles from the Marquesas. At station No. 23, off the Marquesas, in 1802 fathoms, the temperature was 35.5°.

Owing to the failure of our deep-sea thermometers we were not able to make any satisfactory serial-temperature observations. At station No. 11, lat. 14° 38′ N., long. 136° 44′ W., we obtained: 79° at surface, 78.7° at 50 fathoms, 55.9° at 100 fathoms, 48.9° at 200 fathoms, 44.1° at 300 fathoms, and 38.9° at 700 fathoms. These temperatures are somewhat higher than those obtained by the *Challenger* in similar latitudes on their line to the westward of ours between the Sandwich Islands and Tahiti.

The temperatures of the bottom between the Marquesas and Paumotus were 34.9° at 1932 fathoms, 35° at 2456 fathoms and 2451 fathoms, and 35.1° at 2527 fathoms.

We did not take any bottom temperatures between the Paumotus and Tahiti.

Our deep-sea nets not having reached San Francisco at the time we sailed, we limited our pelagic work to surface hauls, of which we generally made one in the morning and one in the evening, and whenever practicable some hauls with the open tow nets at depths varying between 100 and 350 fathoms. The results of these hauls

were very satisfactory. The collection of surface animals is quite extensive, and many interesting forms were obtained. As regards the deeper hauls, they only confirm what has been my experience on former expeditions: that beyond 300 to 350 fathoms very little animal life is found, and in the belt above 300 fathoms, the greater number of many so-called deep-sea crustaceans and deep-sea fishes were obtained. I may mention that we obtained Pelagothuria at about 100 fathoms from the surface.

We trawled at station No. 10 in 3088 fathoms. Unfortunately the trawl was not successful, and we simply hauled the bag through over 3000 fathoms without bringing up a single deep-sea animal from intermediate depths which we did not obtain quite near the surface—at less than 300 fathoms. I may mention here that the experience of the *Valdivia* shows, from the preliminary reports published by Professor Chun, that no pelagic algæ extend to beyond about 150 fathoms. Although he also states that animal life is found at all depths from the surface to the bottom, yet he states that beyond 800 meters it diminishes *very rapidly*. Professor Chun does not state whether this diminution is more rapid away from land than near continental areas, both of which conditions I had called especial attention to in my preliminary report on the *Albatross* expedition of 1891, while using the Tanner net in the Gulf of California. Mr. George Murray has criticised the action of the Tanner deep-sea net and condemns its results, suggesting that the bottom net had always closed some time after being sent down. I need not now discuss that subject, but will only refer him to the report of the *Albatross*, in which he will find the closed part of the net to have on several occasions brought up (when I expected it to do so) specimens from over 600 fathoms from immediately above the bottom, or samples of the bottom from near 1700 fathoms while attempting to tow immediately above that depth. I ought, in justice to him, to state that I omitted to mention that we secured the loops by twine to the detacher, to insure their dropping only when the messenger reached the detacher, and that the hooks of the detacher were lengthened very considerably above the dimensions figured in my preliminary report on the *Albatross* in 1891. I might add that we made a number of trials near the surface to see the action of the Tanner net under all conditions of position and speed, and I can only assume that Mr. Murray, having no experience, did not handle his net properly, or that it was not properly balanced. I may also add that Captain Tanner used his modified net subsequently in the *Albatross*, while running a line of soundings from San Francisco to Hawaiian Islands, in from 100 to 350 fathoms from the surface, at considerable distances from the islands and the mainland, and also in Alaskan waters, and always with the results we had obtained before. The closed bag, when towing at 100 fathoms below the surface, always brought up a mass of pelagic animals living at about that depth, while when tried at 300–350 fathoms, it brought up little or nothing. There is nothing in Captain Tanner's experience, or mine, to indicate why the net should act well at 100 fathoms and not well at 300 fathoms or more, as suggested by Mr. Murray.

On our way to Tahiti from the Marquesas we stopped a few days to examine the westernmost atolls of the Paumotus. Striking Ahii we made for Rairoa, the largest of the Paumotu group, skirting the northern shore from a point a little west of Tiputa Pass; we entered the lagoon through Avatoru Pass, anchoring off the village. This pass is quite narrow, with a strong current running out the greater part of the time, especially in easterly winds. It varies in

depth between 9 and 10 fathoms, shoaling near the inner entrance to about $3\frac{1}{2}$ fathoms, and deepening again to 6 or 7 fathoms, and gradually passing into 15 to 17 fathoms, which is the average depth of the lagoon from Avatoru Pass to the south or weather shore, a distance of about 13 miles.

We made an examination of the northern side of the lagoon, between Avatoru and Tiputa passes. The lagoon beach of the northern shore is quite steep, and is composed of moderately coarse broken coral sand at the base, and of larger fragments of corals along the upper face, which is about 5 to 6 feet above high-water mark. These coral fragments are derived in part from the corals living on the lagoon face of the northern shore, and in part of fragments broken by the waves from somewhat below the low-water mark. The ledge which underlies the beach crops out at many places on the lagoon side of the northern shore; we traced it also along the shores of Avatoru Pass, and about half way across the narrow land running between Avatoru and Tiputa passes. It crops out also at various points between them in the narrow cuts which divide this part of the northern land of the lagoon into a number of smaller islands. These secondary passes leave exposed the underlying ledge, full of fossil corals. In some cases there is left a clear channel extending across from the lagoon to the northern side through which water flows at high or half tide. In other cases the cuts are silted up with coral sand blown in from the lagoon side. In others, the cut is shut off by a high sand-bank, or a bank composed of broken fragments of corals, leaving access to the water from the northern shore only; and finally the cuts are also shut off on the northern side by sand and broken coral banks, the extension of the north-shore beach leaving a depression which at first is filled with salt water and gradually silted up both from the lagoon side and the sea side, and forms the typical north shore land of the lagoon. This building up of the land of the Paumotu atolls simultaneously both by the accumulation of sand from the lagoon side and the sea face is very characteristic of the atolls of that group. It is a feature which I have not seen so marked in any other coral reef district.

On the lagoon side the slope from the beach is very gradual into 16 and 17 fathoms, and corals appear to flourish on the lagoon slope to 6 or 8 fathoms only, in some cases consisting of Madrepores, Porites, Astræans, and Pocillopores. The corals could be seen over the floor of the Avatoru Passage down to 9 to 10 fathoms; and on the sea face Pocillopores covered the outer edge of the shore platform. This platform is from 200 to 250 feet wide, and was formed by the planing off of the seaward extension of the ledge cropping out in the cuts.

It became very evident, after we had examined the south shore of the lagoon, that the ledge underlying the north shore is the remnant of the bed, an old tertiary coralliferous limestone, which at one time covered the greater part of the area of the lagoon, portions of which may have been elevated to a considerable height. This limestone was gradually denuded and eroded to the level of the sea. Passages were formed on its outside edge, allowing the sea access to the inner parts of the lagoon. This began to cut away the inner portions of the elevated limestone, forming large sounds, as in the case of Fiji atolls, and leaving finally on the south side only a flat strip of perhaps 2500 to 3000 feet in width which has gradually been further eroded on the lagoon side and also on the sea face to leave only a narrow strip of land about 1000 feet in width and perhaps 10 to 14 feet in height, the material for this land having come from the disintegration of the ledge of tertiary limestone, both on the sea face and the lagoon side.

There exist at the lagoon side of both Avatoru and Tiputa passes a number of small islets which also consist of this same tertiary limestone in process of disintegration and transformation to coral sand islets; two of these we found along our line of soundings, the one about 4½ miles from the north side of the lagoon, and the other about the same distance from the south shore. I am told that the eastern extremity of the lagoon is filled with islets and heads consisting of the same limestone rock so characteristic of the north and south shores of the lagoon.

The underlying ledge is not the remnant of a modern reef; its character is identical with that of the elevated limestones of Fiji which are of tertiary age, and the rock is in every respect the same as that I observed on many of the elevated islands of Fiji. The atoll of Rairoa is in a stage of denudation and erosion very similar to that of Ngele Levu, in Fiji, only in Ngele Levu the elevated limestone attains a height of about 60 feet. Our visit to the south shore of the lagoon, both on the lagoon side and on the sea face, left us no doubt regarding the character of the underlying ledge of the north shore. As soon as the south shore was sufficiently near, as seen from the lagoon side, for us to distinguish its character, we could see that the entire shore line was formed of a high ledge of limestone, honeycombed, pitted, and eroded, both by atmospheric agencies and the action of the waves in its lower parts both on the lagoon side and on the sea face. The great rollers of the weather side broke through between the columnar masses of the ledge into the lagoon, and as far as the eye could reach there extended a more or less continuous wall (which is described by Dana as he saw it sailing by in the *Vincennes*). But, on landing, we found this wall to be the sea face of the islands and islets which dot the weather side for the greater part of its length on the southwestern part of the lagoon. These islands and islets are entirely composed of coral sand and coral fragments, formed from the disintegration of the extension of the elevated ledge toward the inside of the lagoon to a distance of about 1½ to 2 miles; and along this very gradual slope of the islands forming the southern edge of Rairoa, corals grow profusely down to 6 or 7 fathoms of water, when the bottom runs into hard coralline bottom similar to that found on all the soundings taken across the lagoon.

The width of the larger islands is about 1000 to 1200 feet, the smaller islands and islets are less, some of the latter forming in reality mere sand buttresses at right angles to the great limestone ledge which flanks them all on the sea face and connects them on the weather side as if by a great wall, more or less broken, and shuts off the communication of the interior of the lagoon with the sea on that side.

The passages between the islands and islets illustrate well, only on a larger scale, the formation of the cuts, more or less silted up, which were observed on the northern face of the lagoon. Some of these passages are dry at low-water, others are partly filled by tide pools, others are entirely silted up by lagoon sand, only they are lower than the sand-blown land of the islands on either side.

Crossing over to the weather side of the southern land of Rairoa, in one of the passages between two of the islands we came upon the limestone ledge, from 12 to 14 feet high and about 40 to 50 feet wide, which formed the sea face of the islands and islets, and extended far to the westward as a great stone wall more or less broken into distinct parts. We found this ledge to consist of elevated limestone as hard as calcite, full of corals, honeycombed and pitted, and worn into countless spires and spurs, and needles and blocks of all sizes and shapes, separated by deep crevasses or potholes, recalling a similar scene in Ngele Levu on the windward side of the lagoon. In the pas-

sages the parts of the ledge which had not been eroded extended as wide buttresses, gradually diminishing in height till they formed a part of the lagoon flat and extended out below the recent beach rock which covered it in short stretches.

The slope of the sea face of the elevated ledge was quite steep and similar to the lagoon slope, its upper surface weathered by atmospheric and aqueous agencies into all possible shapes such as I have mentioned. The slope passed into the shore platform which was shaved down as it were to a general level surface. On the outer edge, within the line of the breakers, were growing Pocillopores in great abundance. This reef flat or shore platform, as well as the reef platform of the north shore, was strewn here and there with huge masses of the ledge of elevated reef rock torn from its outer shore. Similar rocks and bowlders occur on the lagoon side of the islands forming the outer lands of Rairoa; they are either torn off from the lagoon face of the outcropping ledge, or are parts of the ledge which have remained in place and have not been planed down to the base level of the reef.

The amount of water which is forced into such a lagoon as Rairoa is something colossal, and when we observe that there are but a small number of passages through which it can find its way out again on the leeward side, it is not surprising that we should meet with such powerful currents (7 to 8 knots in several cases) sweeping out of the passages on the lee sides.

The islands and islets of Rairoa are fairly well covered with low trees and shrubs and great groves of palm trees.

The atolls of Tikehau and Mataiwa, which we also examined, present no features which we did not meet in Rairoa. The first-named atoll shows the same method of formation of the land by material piled up both from the lagoon side and the sea face; material derived from the disintegration of the underlying tertiary limestone which crops out here and there along the sea face and the inner shores of the lagoon, or forms across the southwest face of the lagoon a more or less disconnected part of the ring of islands and islets encircling that end of the lagoon. These islets and islands are irregularly connected by fragments of the elevated limestone ledge, attesting its greater extension in past times. The outer rings of both these atolls are covered with vegetation. We could see in the lagoons several rocky islets, the fragments of the elevated limestone ledge.

Mataiwa is interesting, as its lagoon is quite shallow; it is full of rocky islets, remnants of the underlying limestone ledge which crops out above the general level, and has a very narrow and shallow entrance, passable for boats only. Some of its islands are wooded and appear to have been formed by accretions of sand from the decomposing ledges of the lagoon. The outer ring of land appears formed by sand banks driven in from the sea face and driven out from the lagoon side by the action of the waves. It is evident that such a lagoon as Mataiwa could readily be closed to any access to it by the sea, as it now has only one very narrow and very shallow boat passage connecting the lagoon with the sea on the lee side.

It was with great interest that we approached Makatea, as it is the only high elevated island of which Dana speaks as occurring in the western Paumotus. For though he mentions some others as possibly having been elevated 5 to 6 feet, yet he considered them, all as well as Makatea (Metia or Aurora, of Dana), as modern elevated reefs. Yet from the very description given by him of the character of the cliffs and of the surface of Makatea, I felt satisfied that it was composed of the same elevated coralliferous limestone so character-

istic of the elevated reefs of Fiji, and which, from the evidence of the fossils and the character of the rock, both Mr. Dall and myself have been led to regard as of tertiary age.

As we approached the island from the northwest it soon became evident that it presented all the characteristics to which I had become so accustomed in Fiji, and, upon landing, this was found to be the case. The cliffs had the same appearance as those of Vatu Leile, Ongea, Mango, Kambara, and many other elevated islands of Fiji. There were fewer fossils perhaps, but otherwise the petrographic character of the rock was identical with that of Fiji. Mr. Meyer collected upon the top of the second terrace a number of fossils similar in all respects to those we found in the Fiji elevated coralliferous limestones.

The southwestern extremity of the island sloped gradually to the sea and showed two well-defined terraces. The lines of these two terraces could, as a rule, be traced along the faces of the vertical cliffs by the presence of caverns along the lines of those levels, similar to the line of caverns indicating the line of present action of the sea at the base of the cliffs. As we steamed around the island there were distinct indications of two additional terraces on the line of the vertical cliffs on the weather side of the island. The position of these terraces was usually more clearly seen along the face of the cliffs at prominent points where they were undercut much as I have figured them for certain cliffs in Vatu Leile, in Fiji, in my report on the islands and coral reefs of that group.

Of course it is premature from this examination of the western extremity of the Paumotus to base any general conclusions regarding the mode of formation of these atolls ; certainly as far as I have gone there is absolutely nothing to show that the atolls of the Paumotus have not been formed in an area of elevation similar to that of Fiji. The evidence in Rairoa and in the atolls of the western Paumotus is very definite. Makatea is an elevated mass of coralliferous limestone similar in all respects to masses like Vatu Vara, Thithia, and others in Fiji. Like them Makatea is surrounded by a comparatively narrow shore platform cut out from the base of the limestone cliffs and on the seaward extension of which corals grow abundantly to depths of 7 to 8 fathoms, when they appear to become very much less numerous. So that it is not unnatural, as I am inclined to do, to look upon the area of the Paumotus as one of elevation, the raised and elevated land of which has been affected much in the same way by denudation and erosion as have the masses of elevated coralliferous limestone of Fiji. Only there seems to have been, from the evidence thus far presented, a far greater uniformity in the height of the elevation of the Paumotus. This would render the explanation I have given less evident had I not the experience of the Fiji group to guide me. I am informed that there are other islands and atolls in the Paumotu group, showing traces of this elevation, so that I am at any rate justified in denying that the Paumotus as such are situated in an area of subsidence and that subsidence has been the great factor, as is maintained by Darwin and Dana, in the formation of the characteristic atolls of the group.

It may be well to point out also that the Paumotus, like the Marquesas on one side and the Society Islands on the other, are situated upon a plateau similar to that upon which the last mentioned groups are placed—this plateau having a depth of from 1200 to 1500 fathoms and rising from the general oceanic basin which surrounds them and which has a depth of from 2300 to 2500 fathoms. Furthermore, evidence of this elevation is found at the two extremi-

ties of the Paumotu plateau, at Makatea, an elevated island consisting of tertiary coralliferous limestone and at the Gambier Islands which are volcanic islands of considerable height.

A. Agassiz.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

II.

THE REVISED HARVARD PHOTOMETRY.

In the Harvard Photometry, all stars were inserted having the magnitude 6.0 or brighter in any of the principal star catalogues then published. Accordingly, as was expected, many fainter stars were included, since a star really faint, but estimated bright by mistake in any of these catalogues, would be entered and measured. It appears that from this cause, and from the varying scale in different catalogues, more than six hundred stars are included, which are fainter than the magnitude 6.2 on the photometric scale. (See H. C. Annals, Vol. XIV., p. 479.) Numerous measures of the brighter stars have been made in recent years, with the large meridian photometer which has replaced the instrument first used. They include 823 stars measured in connection with fainter stars in Vol. XXIV., Table I., and 1179 stars in Vol. XXIV., Table IV. Measures of all of the bright stars south of declination — 30°, are published in Vol. XXXIV.

The stars of the Harvard Photometry were again observed in 1892–1894, and the results are now being published in Vol. XLIV. A large number of them were also measured in 1895–1898, when determining the brightness of stars of the magnitude 7.5 and brighter north of declination — 40°. Finally, the stars south of declination — 30° are now being remeasured in Arequipa, by Professor Bailey. In a recent letter, he states that sixteen series were obtained on sixteen successive nights, and that 11,448 settings were made during the month of May, 1899. It is hoped that this work will be completed during the present year.

It, therefore, appears that seven photometric catalogues of these stars have been prepared. In Vol. XXIV., Table I., some stars were observed on only two nights, but in all the other catalogues the minimum number of nights is three, and for many of the stars, especially for those that are bright, the number is much greater. When the observations were not accordant the minimum number of nights was five in Vol. XXIV., Part I., and seven or more in the other catalogues. The number of photometric settings on each star each night was generally four, but was occasionally eight or more in the later work. The total number of photometric settings, including those of the fainter stars, will slightly exceed one million. It will be seen, therefore, that a large number of measures of all the bright stars have been made according to the same plan, but with different instruments and by different observers. Each star should appear in at least two of the seven catalogues, and generally in three or more.

It is, therefore, proposed to issue a catalogue of all the stars from the north to the south pole of the magnitude 6.0 or brighter according to the meridian photometer, which will show the brightness as given in each of the seven catalogues. This work, which will be called the 'Revised Harvard Photometry,' will also contain other facts, such as the approximate right ascension and declination for 1900; the designation according to Bayer, Flamsteed, the *Durchmusterung*, the Argentine General Catalogue, the Harvard Photometry and the Southern Harvard Photometry; the magnitude according to Herschel, the *Durchmusterung*, the Argentine General Catalogue, the *Uranometria Oxoniensis*, and the Potsdam Catalogues; the class of spectrum, and, if pos-

sible, the photographic magnitude. This would also furnish a quantitative measure of the color.

As it is believed that this catalogue will be found convenient for general reference, the value would be greatly increased if the precise position, the precession, the secular variation, and the proper motion were added. This does not seem advisable, however, since owing to the uncertainties of proper motion, and systematic errors in various catalogues, the labor involved in this work would be very great, and probably many astronomers would be dissatisfied with the results, however obtained. A simple plan would be, for the northern stars, to take the positions for 1875 given in the catalogues of the *Astronomische Gesellschaft*, and for the southern stars those given in the Argentine General Catalogue. Residuals for a few other catalogues could be given and thus permit other places to be used if desired. These positions would be sufficiently accurate for stars of the eighth and ninth magnitudes, but they would be far from representing the accuracy with which the places of the brighter stars are known. Any suggestions and criticism relating to the above plan will be gratefully accepted, as it is not yet too late to make use of them.

G. C. Comstock : *Some Researches in Stellar Color.*

By placing a coarse grating in front of the objective of a telescope the image of a star is broken up into a series of spectra symmetrically placed on opposite sides of a central image, and, as is well known, the distance of the several spectra from the central image depends upon the grating interval and the wave-length of the light in question. When the grating interval is large, *e. g.*, 10 mm. to 50 mm., the first order spectra of stars are almost indistinguishable from stellar points, and if their angular separation is measured with a filar micrometer an excellent determination of the mean wave-length of the light in question is easily obtained. Observations of this kind are in progress with the 40 cm. equatorial telescope of the Washburn Observatory, special attention being given to colored stars and to the planet Mars for the purpose of determining any possible effect of the stellar and planetary color upon observations for the determination of the solar parallax. While definite results are not yet obtainable, it may be stated in general that the mean refrangibility of the light of Mars is markedly less than that of any red stars yet examined.

Attention has also been given to the color of Jupiter's satellites on account of the application of interference methods to the determination of their diameters made by Michelson and Hamy. Both of these investigators appear to have assumed too small values of the mean wave-length, that of Hamy requiring to be reduced about twelve per cent.

F. L. Chase : *Refraction of Red Stars.*

Gill in 1877 and Newcomb in 1895 have spoken of the importance of the effect that a difference in the refraction of Mars and minor planets from that of the comparison stars might have on the apparent parallaxes of the planets. Although feeling that in case of *Victoria* and *Sappho* this color effect was inappreciable, as stated in his recent work on the solar parallax, Dr. Gill requested the several observatories engaged in the solar parallax work to make a short series of heliometer observations on several highly colored stars. Not having time to carry out the program suggested by Dr. Gill, the author selected five other suitable stars and carried out the work as follows:

The plan was to observe the distances between the red star and each of two nearly equally distant comparison stars, one preceding in right ascension and the other fol-

lowing it, and as nearly as possible on the same parallel of declination with it, first at a rather large hour angle when east of the meridian and again in the morning hours when west. Now it is evident that if the red star is lifted less by refraction than a comparison star which precedes it in right ascension, the distance between them on the east side of the meridian will be greater than it would be if both stars were white and less on the other, and *vice versa* if the comparison star follows it. By taking two comparison stars as described above we are able to eliminate any change in the scale value, any variation in the atmospheric refraction, and the difference of the two measured distances would evidently give double the effect we are considering.

Now the refraction of a star of average color may be represented by

$$R = \beta \tan z.$$

The refraction of a star with light of a different refrangibility would then be

$$R = (\beta + d\beta) \tan z.$$

It will therefore be easily seen that the refraction correction to the observed distance between two stars of different refrangibility should receive an additional correction

$$- d\beta \tan z \cos (p - q),$$

z, p and q having their usual significations of zenith distance, position angle, and parallactic angle, respectively.

To each measured distance it would then be simply necessary to add the term

$$- d\beta \tan z \cos (p - q)$$

and to find the value of $d\beta$.

Now for finding of the value of $d\beta$ the observations of each of the five red stars which were to be observed four times on each side of the meridian, would furnish eight equations of condition of the form

$$x + a d\beta = n,$$

where x is the necessary correction to the assumed value of the difference between the distances from the two comparison stars; a is the value of $\tan z \cos (p - q)$, and n is the observed difference of the two distances minus the assumed difference.

Combining the normals derived from these equations of condition for the observations of both last year and this, and solving, I find the following values for $d\beta$:

Star.	Redness.	$d\beta$.	Wt.
R_1	6.0	$+0.''020 \pm 0.''015$	63.6
R_2	7.1	$-0.''008 \pm 0.''014$	16.0*
R_3	7.0	-0.015 ± 0.020	64.4
R_4	8.7	-0.046 ± 0.018	45.2
R_5	7.8	$+0.008 \pm 0.024$	55.7

Average probable error 1 observation $= \pm 0.''151$.

A separate investigation was made along with that of star R_5, which was specially selected because it had a close neighboring white star. The distances of the white star from the same comparison stars were measured on the same nights and the observations were made symmetrically with respect to those of the red stars, so that the conditions were absolutely the same for the two stars.

Similar equations for this white star gave

$$d\beta = + 0.''004 \pm 0.''022, \text{ wt. } 55.6$$

as compared with $+ 0.''008 \pm 0.''024$ for R_5.

The small values above found for $d\beta$ (in the mean for five red stars we find $d\beta = - 0.''006 \pm 0.''010$), and more especially the fact that two contiguous stars, one white and the other red, give no appreciably different results, afford rather forcible evidence that to my eye, at least, difference of color in the stars does not effect heliometer observations of distance.

J. E. Keeler: *The Ring Nebula in Lyra.*

In order to test the capabilities of the Crossley three-foot reflector of the Lick Observatory, a number of photographs were made of well-known celestial objects. As the focal length of a camera should be from thirty to sixty times its aperture in order

* Not observed in 1899.

that the photographic and optical resolving power may be equal, it is doubtful if this nebula has ever been photographed with an entirely suitable instrument. As it is a small object and photographically bright, it could be advantageously photographed with a reflector of unusually long focus. The lenses of refractors absorb the actinic rays to such an extent that for such instruments exposures of even twenty hours have been given to this nebula. With the Crossley reflector, under the finest conditions, on July 14th of this year, an exposure of 30 seconds produced an image which was barely visible; one minute a faint image; two minutes a distinct image, and ten minutes exposure gave the best general picture of the nebula. With one and two hours the plate was much overexposed. The focal length of this telescope is 17½ feet, but if it were four times greater a far better photograph could doubtless be obtained, the necessary exposure then being about three hours.

The ratio of aperture to focal length could, however, be reduced by cutting down the aperture, thus diminishing the aberration and atmospheric disturbances. But for an object like this nebula the aberration is insensible, the star images being excellent at half an inch from the axis; moreover the photographs were taken on nearly perfect nights when the definition would not have been improved by reducing the aperture.

These photographs of the ring nebula show features described by observers with powerful visual and photographic telescopes, and others which appear to be new. The outline of the nebula is oval rather than elliptical, with faint structureless fringes of nebulosity projecting on both sides of the oval. The ring has quite a complicated structure, as if made up of several narrower bright rings, interlacing somewhat irregularly, the intervening space being filled with fainter nebulosity.

A comparison was given of the dimensions of the nebula as measured by Barnard with the Lick refractor, and as determined by Stratonoff on photographs obtained in 10 hours exposure with a refractor of 33 cm. aperture, and as measured on a Crossley plate with 10 minutes exposure. The author's measures give a somewhat greater size than the visual measures, and also average slightly more than on the Russian photograph.

Lord Rosse's drawing, published in the *Philosophical Transactions* for 1844, showing the interior space of the nebula to be crossed by a series of dark and bright bands, and hitherto generally deemed fanciful, is now confirmed, it is believed, for the first time.

The actinic power of the central star, noted by many observers, is also confirmed by these plates, being faintly visible on the plate exposed for thirty seconds. It is suggested that the photographic strength of this and other central stars may be due to bright lines, probably of hydrogen, in the upper spectrum; and the author does not anticipate difficulties in photographing their spectra. On all the photographs the central star is as clearly defined as are other stars outside the nebula; there is no evidence of blending into the nebulous background. This is also the appearance of the star as seen with the 36-inch refractor. (Published in the *Astrophysical Journal.*)

W. W. Campbell: *The Wave-length of the Green Coronal Line.*

One of the problems undertaken by the expedition sent from the Lick Observatory to observe the Indian eclipse of January 22, 1898, was the determination of the rotation of the corona from the displacement of the green coronal line. A powerful train of prisms loaned by Professor Young furnished the necessary high dispersion. A successful plate was obtained during the eclipse, and while measuring this in January, 1899, I learned that Lockyer had assigned a new wave-length to the green coronal line. On

reducing my measures, with the aid of Hartmann's formula, I obtained a result in substantial agreement with his. The wave-length is

For East side, λ 5303.21
For West side, 5303.32

Mean, λ 5303.26,

which should not be in error by more than ± 0.15 tenth meters. The difference in the determinations for the two sides corresponds to a relative velocity of 6.2 km. in the line of sight, or a rotational velocity of 3.1 km. per second. However, I regard this result as subject to a possible error of at least ± 2 km. per second, partly on account of unavoidable errors of observations, but principally on acount of the ill-defined and unsymmetrical character of the bright line.

The continuous spectrum of the inner corona was recorded out to a distance of 2.′5 on the east side and 1.′5 on the west side. While the dark lines in the recorded comparison spectra are sharp and strong, there is not the slightest trace of dark lines in the recorded continuous spectrum of the corona. This radiation seems to be of coronal origin, and is not due to reflected photospheric radiations.

In explanation of the error in the accepted value of the wave-length (λ 5317) of the green coronal line which has prevailed for many years, it is suggested that the true coronal line would be difficult to observe so long as the chromospheric spectrum was visible. Hence the observers, setting on the strongest chromospheric line in this region, at λ 5317, which is very conspicuous just before and at the instance of totality, assumed it to be identical with the true coronal line, and located it at 1474K. Later, when this line had disappeared, rather suddenly, and the background had become dark enough to allow the line at λ 5303 to be seen, the observers were interested in the extent and other properties of the line and no further micrometer settings were made for fixing its wave-length. (Published in the *Astrophysical Journal.*)

EDWIN B. FROST: *Notes on the Reduction of Stellar Spectra.*

The advantage was pointed out of using Hartmann's interpolation formula for the prismatic spectrum in the reduction of spectrograms taken either for the determination of wave-lengths or velocity in the line of sight. An outline was given of the procedure adopted in the latter work with the 40-inch refractor. Each plate is reduced by itself, independently of any solar or other plate, such as many observers have used as auxiliary in the process of reduction. The comparison spectrum from a spark between metallic electrodes, impressed upon each plate, furnishes all the data necessary for reduction. It is hoped that errors due to effects of temperature on the dispersion of prisms and focus of lenses are thereby reduced, and that systematic errors are also diminished.

Attention was called to the favorable results obtained from the use of titanium as a source of the comparison spectrum. The lines are numerous and well distributed throughout the upper spectrum. The metal stands third in Rowland's arrangement according to number of lines in the solar spectrum. The spark passes with great readiness between electrodes of metallic titanium, and the air lines, which are annoying in case of the spark spectrum of iron, are not produced. Sharp titanium lines are found to fall at points in the spectrum close to the positions of the principal lines of stellar spectra of Type 1*b*, and thus facilitate the reduction of such spectra.

Corrections to Determinations of Absolute Wave-length.

The effect upon the absolute wave-length of lines in the solar spectrum of the eccentricity of the earth's orbit seems to have

been hitherto neglected, presumably because the observers deemed it insignificant. The largest values, however, of the motion of the Earth toward and from the Sun, due to this cause, amount to 0.50 kilometer per second, in April and October; and if velocities of stars in the line of sight were determined directly from absolute wave-lengths, instead of relative wave-lengths, uncertainties of one-half of a kilometer would at once arise, in measurements now given to the tenth of a kilometer. Expressed in wave-lengths that velocity would produce a displacement of 0.011 *tenth-meters* at *C*; or 0.008 at *F*.

The diurnal correction to velocities in the line of sight, due to the Earth's rotation, also seems to have been omitted in reducing measures of absolute wave-length. This might have an effect up to 0.006 tenth-meter at *C* or 0.005 at *F*.

The need of even a higher degree of accuracy than that yet obtained in relative wave-lengths was urged, as an error of 0.01 tenth-meter in the relative wave-length of either a stellar or comparison line (not coincident) whose separation is measured, produces an error of 0.7 kilometers per second in the velocity of the star as deduced from that line. (To be published in the *Astrophysical Journal.*)

FRANK SCHLESINGER: *Suggestions for the Determination of Stellar Parallax by Photography.*

As the star to be examined for parallax will usually exceed each of the comparison stars in brightness by six or seven magnitudes, the first problem is to reduce in some way most of the light of the brighter stars, in order to escape various errors which would arise in the measurement of star disks very unequal in size and appearance. It is suggested that the portion of the photographic film upon which the light of the principal star will fall be previously treated with some suitable dye, thus greatly reducing its photographic action.

To avoid a second source of error, distortion of the film after exposure, a modification of the method employed by Wilsing is suggested. Let two pictures be taken close to each other on the same plate at the first date; let the plate then be stored undeveloped in a dark room; after six months make two more exposures of the same star and comparison stars on the plate at a little distance from the previous impressions; this plate can then be developed and measured, without fear of any ill effects from distortion of the film. The first pair of exposures on a new plate may then be begun, and this stored for six months; and so on until a sufficiently long chain of plates is secured to give good values both for the parallax and for relative proper motions with respect to comparison stars.

It is proposed that errors of optical distortion caused by peculiarities of the object-glass be eliminated from the parallax by rotating the lens in its own plane through 180° each time that the telescope is reversed. In this way the objective will present the same position relative to a stellar configuration, whether in the east or west, and optical distortion, if any, will shift all images of the same star alike.

According to the author's estimate, a single observer working 15 or 18 hours a week at the telescope and employing the rest of his time in measuring and reducing, could give us in three or four years the parallaxes of 200 stars with an accuracy hitherto attained for only a score. (To be published in the *Astrophysical Journal.*)

S. I. BAILEY: *Periods of the Variable Stars in the Cluster Messier 5.*

This cluster contains about 900 stars on the photographs made with the 13-inch Boyden refractor, of which about eighty-five, or one in eleven, are variable. The

periods of about forty stars have been determined from measures made of 63 of these variables on nearly 100 plates by the author and Miss E. F. Leland. The period and light curve of one of the stars in this cluster were determined by Professor E. C. Pickering in 1896, and the periods of three others by visual observations with the Yerkes refractor. A tabular statement was given of the periods, maximum and minimum brightness and range, and distance from the center of the cluster. Drawings were exhibited of the light-curves of the first eight variables in the group. The table disclosed a striking similarity among all these variables, not only in regard to length of period, but in magnitude and range of variation. Excepting No. 9, which has the exceptional period of $16^h\ 47^m$, the longest period among the 40 stars is $14^h\ 59^m$, and the shortest $10^h\ 48^m$. The average period is $12^h\ 37^m$, so that the greatest deviation in period from the mean is $2^h\ 21^m$. At maximum these variables range between 13.4 and 13.9 mags., and at minimum between 14.5 and 14.9 mags. The uniformity of period, magnitude, and light-curve among so many variables in the same cluster points unmistakably to a common origin and cause of variability. No such uniformity is found in the periods and light-curves of over one hundred variables determined by the author in the great cluster *ω Centauri*.

A few of the variables in M. 5 have been studied with special care for the exact determination of the form of the light-curve, and diagrams were shown of two of these, which represent what may be called the 'Cluster Type' of variables. The decrease in brightness is rapid, but not nearly so rapid as the increase. The duration of maximum phase is exceedingly brief, if any; the minimum brightness appears to be quite constant for several hours. The whole period may be divided as follows:

Duration of maximum phase	0	per cent.
" " minimum "	40	" "
" " decreasing "	50	" "
" " increasing "	10	" "

Note on the Relation between the Visual and Photographic Light-curves of Variable Stars of Short Period.

With a visual telescope of sufficient power a series of frequent observations of a variable star will give the true form of its light-curve, since each observation consumes so little time that it is not affected by the star's variability. The same would be true of photographic observations if the time of exposure could be made so short as to bear an inappreciable ratio to any change of phase. This applies to most long-period variables. Certain short-period variables, however, notably those belonging to dense clusters, are so faint and go through their changes, especially the increase in light, so rapidly, that the necessary exposure bears a very large ratio to the duration of any phase and important modifications in the form of the light-curve follow.

When the light of a star is changing at a uniform rate and in the same direction, the measured magnitude will approximately represent the actual photographic magnitude at the middle time of exposure, but it is obvious that sharp changes in the light of a variable will not be well registered on photographs of relatively long exposure. A diagram was shown of an assumed light-curve, where the exposure required was one-half of the period of the star's entire variation, and the rise and fall of the brightness were equally rapid. Here no photograph of the required exposure would record a complete minimum, but would fall above it, and similarly would fall below the true maximum. Thus the tendency of the photographs is to smooth down the curve, reducing the star's apparent range of variation.

Where the increase and decrease of light

are of different rapidity, as is usually the case, the result will be different. A diagram was shown of a slightly modified light-curve of variable No. 7 of cluster M. 5. In order to represent the variable at a complete minimum the exposure must close before the beginning of the maximum phase. The photograph, the middle of whose exposure is at the beginning of maximum, will have the first half of its exposure at minimum and will record the variable as of less than maximum brightness, and the maximum possible on such plates will be recorded on the exposure commencing at the beginning of maximum. With the usual exposure of one hour for this cluster, the photograph beginning an hour before maximum would record the minimum photographic magnitude. This retardation will depend upon the light-curve and the exposure time. In general the difference in time between the photographed and the actual maximum or minimum varies, with zero as a limit, as the exposure is reduced. Evidently a large telescope and very sensitive plates are desirable.

Probably the shortest period yet found is that of No. 91 in *ω Centauri*, $6^h\ 11^m$; as it is not improbable that much shorter periods may be discovered, it is clear that the relation of the exposure to the period becomes very important. (To be published in the *Astrophysical Journal.*)

Neither the original papers nor abstracts have been obtained of the following:

William Harkness: *On the Semi-Diameters of the Sun and Moon.*

F. R. Moulton: *Problems in Modern Celestial Mechanics Treated by the use of Power Series. Laplace's Ring Nebular Hypothesis.*

The committee on the total solar eclipse of May 28, 1900, consisting of Professors Newcomb, Barnard, Campbell and Hale (Secretary), presented this preliminary report:

THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.

The committee on the total solar eclipse of May 28, 1900, appointed at the Second Conference of Astronomers and Astrophysicists, presents herewith a preliminary report.

The aim of the committee has been:

1. To ascertain the opinion of astronomers regarding the best means of securing coöperation, the most important classes of observations and the best means of making them, and the plans of the various eclipse parties.

2. To collect other information likely to be useful to persons planning to observe the eclipse.

For the purpose of securing information on the various points referred to in paragraph (1) a circular letter was addressed to American astronomers. From an examination of these replies it appears:

1. That there is a general willingness to coöperate with the committee in securing thorough observations of the eclipse phenomena and effective distribution of stations along the line of totality.

2. That, in the opinion of those from whom the replies were received, the most important observations includes studies of the minute structure of the corona, both visually and by means of large scale photographs; photography of the flash spectrum and determination of the wave-length of the green coronal line; measurement of the heat radiation of the corona; photographic search for an intra-mercurial planet.

3. That several institutions, including the Princeton, Lick, Naval, Goodsell, Chabot, Flower and Yerkes Observatories, will probably be represesented by well-equipped parties, while a considerable number of astronomers with good instrumental equipment will take part as individuals.

4. That no general appeal to the public for funds is required, as each institution will endeavor to secure the amount necessary for its work.

5. That the work already planned includes observations of contacts, photography of the corona with large and small cameras; visual and photographic observations of the spectrum of the sun's limb and of the corona; visual examination of the details of the coronal structure; measurement of the brightness of the sky at different distances from the sun; search for an intra-mercurial planet; and observations of the shadow bands.

A preliminary report on the weather conditions along the line of totality has been prepared by the Weather Bureau, at the request of the committee. From this it appears that interior stations are probably to be preferred to those on the seacoast, in spite of the shorter duration of the total phase. The full report of the Weather Bureau, which will soon be published, will contain much valuable matter, including maps of the eclipse track, showing location of towns and railways; information regarding hotel accommodations, desirable sites, etc.

It is understood that the Naval Observatory will issue instructions to observers, and that a map of the eclipse track will be published by the Nautical Almanac Office. The Treasury Department has made arrangements by which the instruments of foreign parties will be admitted free of duty.

The committee, if authorized by the conference to continue its work, will be glad to receive and publish further information from eclipse parties regarding their plan of observations and location of stations.

Extracts from the replies of various astronomers were appended to the report, but need not be reproduced here, as they have been published in the *Astrophysical Journal*. The committee was continued in office.

The committee appointed at the Second Conference to act in reference to the questions at issue regarding the United States Naval Observatory also reported that the opinions of astronomers regarding that institution, which had been obtained in response to a circular letter, had been communicated to the Secretary of the Navy. This report is not reproduced here, as it is practically superseded by the official report of a Board of Visitors appointed by the Secretary of the Navy to visit, examine and report upon the Naval Observatory. The recommendations of this official report have been given in full in SCIENCE.

The first meeting of the Astronomical and Astrophysical Society of America adjourned at noon, September 8th.

EDWIN B. FROST,
Acting Secretary.
YERKES OBSERVATORY, WILLIAMS BAY, WIS.

AMERICAN ORNITHOLOGISTS' UNION.

THE Seventeenth Congress of the American Ornithologists' Union convened in Philadelphia, on Monday evening, November 13th. The business meeting was held in the Council Room, and the public sessions, commencing Tuesday, November 14th, and lasting three days, were held in the Lecture Hall of the Academy of Natural Sciences.

Robert Ridgway, of Washington, D. C., was reëlected President; Dr. C. Hart Merriam, of Washington, D. C., and Charles B. Cory, of Boston, Vice-Presidents; John H. Sage, of Portland, Conn., Secretary; and William Dutcher, of New York City, Treasurer. Charles F. Batchelder, Frank M. Chapman, Ruthven Deane, Witmer Stone, Drs. A. K. Fisher, Jonathan Dwight, Jr., and Thos. S. Roberts, were elected members of the Council. By a provision of the by-laws, the ex-Presidents of the Union, Drs. J. A. Allen and Elliott Coues, and Messrs. William Brewster and D. G. Elliot, are *ex-officio* members of the Council.

Two corresponding and eighty-five associate members were elected.

Miss Juliette A. Owen, of St. Joseph, Mo., an associate member, donated $100 to the Union 'to be devoted to any ornithological purpose that might seem fitting to the Council.' Miss Owen wrote that the amount sent was about the cost of the journey she expected to take in order to attend the Congress, but was prevented from going. The sum received will be the nucleus of a fund which it is hoped may be secured, the income to be spent for the advancement of the science of ornithology.

An honored visitor to the daily sessions was Dr. Samuel W. Woodhouse, of Philadelphia, after whom Prof. Baird named the Woodhouse's Jay (*Aphelocoma woodhouseii*) more than forty years ago. Dr. Woodhouse is in most excellent health and still interested in scientific work.

Mr. Louis Agassiz Fuertes exhibited and explained a series of field sketches made by him in Alaska the past season. They showed the true life colors of the soft parts, mostly in the breeding season.

By courtesy of Miss Lucy H. Baird, Mr. Witmer Stone was able to compile and read the letters of John J. Audubon to the late Spencer F. Baird, then of Carlisle, Pa. These covered the period from the reply to the inquiry of the lad Baird concerning the identity of a flycatcher until after the return of Audubon from the Missouri river in 1843. The letters are of great historic interest and show the warm feeling of the older naturalist toward his young friend and companion.

Wednesday afternoon was devoted to papers illustrated with lantern slides. The following papers were read:

'An Account of the Nesting of Franklin's Gull (*Larus franklinii*) in Southern Minnesota': Dr. Thos. S. Roberts; 'Bird Studies with a Camera': Frank M. Chapman; 'Home Life of Some Birds': Wm. Dutcher. 'The Effects of Wear upon Feathers,' Dr. Jonathan Dwight, Jr.; 'Slides—Series of Kingfisher, Gulls, etc.': Wm. L. Baily.

In a pleasing conversational way Dr. A. K. Fisher told of the more interesting birds found by the recent Harriman Alaskan Expedition. The notes of the birds referred to were imitated by Mr. Fuertes, also a member of the Harriman party.

The report of the Committee on Protection of North American Birds, read by its Chairman, Mr. Witmer Stone, showed that an increased interest is taken at the present time in the preservation of wild bird life. Investigation proved that many of the birds now used in millinery were imported from countries where there are no bird laws. The committee had used its influence to prevent excessive collecting of eggs and skins for commercial purposes.

On Friday, November 17th, after adjournment of the Union, at the invitation of Mr. W. H. Wetherill, owner of the property, Mr. George Spencer Morris conducted a party to Mill Grove, on the Perkiomen, the former home of Audubon. Mrs. Morris F. Tyler, of New Haven, Conn., wife of the treasurer of Yale University, a granddaughter of Audubon, was one of the party.

The attendance of members at the Congress just closed was much larger than at any previous one. They came from distant parts of the United States, and from Canada.

Following is a list of the papers read at the sessions in addition to those already mentioned:

Notes on the Flammulated Screech Owls: Harry C. Oberholser; Three Years' Migration Data on City Hall Tower, Philadelphia: William L. Baily; A Quantitative Study of Variation in the Smaller American Shrikes: Reuben M. Strong; Behring Sea Arctic Snowflake (*Passerina hyperborea*) on its Breeding Grounds: C. Hart Merriman; On the Plumage of Certain Boreal Birds: Frank M. Chapman; On the Perfected Plu-

mage of *Somateria spectabilis*: Arthur H. Norton; The Summer Molting Plumage of Eider Ducks: Witmer Stone; An Oregon Fish Hawk Colony: Vernon Bailey; The Sequence of Plumages and Molts in Certain Families of North American Birds: Jonathan Dwight, Jr.; The Ranges of *Hylocichla fuscescens* and *Hylocichla f. salicicola*: Reginald Heber Howe, Jr.; On the Occurrence of the Egyptian Goose, (*Chenolopex ægyptiaca*) in North America: Frank C. Kirkwood; Further Remarks on the Relationships of the Grackles of the Subgenus *Quiscalus*: Frank M. Chapman; A Peculiar Sparrow Hawk: William Palmer; The Requirements of a Faunal List: W. E. Clyde Todd; Language of the Birds: Nelson R. Wood; A New Wren from Alaska: Harry C. Oberholser; The Molt of the Flight-Feathers in various Orders of Birds: Witmer Stone; Some Cuban Birds: John W. Daniel, Jr.; On the Orientation of Birds: Captain Gabriel Reynaud, French army.

The next meeting will be held in Cambridge, Mass., commencing November 12, 1900.

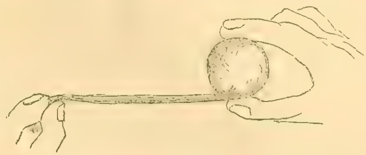
JOHN H. SAGE,
Secretary.

DEMONSTRATING THE CURVE OF THE BASE BALL IN THE LECTURE ROOM.

THE limited space in the lecture room, and the presence of one's audience makes a demonstration of curve pitching difficult even if one has the necessary skill. If the curve is to be made at all apparent in a limited space the ball must be exceedingly light, and the axial rotation very rapid.

I have found the ordinary oak-ball or oak-apple very suitable for this purpose. The rough surface gives the necessary friction, and the ball itself is as light as an egg shell and much stronger.

A strip of rubber band about 15 cms. long and 0.5 cm. wide is wound under tension around the ball (two or three turns are enough), and the ball 'catapulted' forward by means of the remainder of the band as shown in the figure. The ball will rise,



drop, or curve to one side, according to the position in which it is held. A total deflection of 45° is easily obtained, and when pitching the rise (which is the case shown in the figure) the ball, starting in a horizontal direction, will sometimes ascend half way to the ceiling. This curve is the most striking of course, as the attraction of gravitation is overcome. It shows to the best advantage when thrown directly away from the observer, but this of course is difficult in the lecture hall.

These oak balls are also very suitable for showing the suspension of a ball in an air jet.

R. W. WOOD.

THE ANNUAL REPORT OF THE SECRETARY OF AGRICULTURE.

THE report of the Secretary of Agriculture for 1899, just issued, shows that the Department has had a prosperous year and that the volume of its practical and administrative work has largely increased. At the same time there has been advancement in a number of lines of technical and scientific work.

The extension of the Weather Bureau service around the Carribean Sea has been abundantly successful in noting the first indications of cyclones and forecasting their movements. Warnings of cold waves have been particularly successful during the past year. A climate and crop service has been successfully established in Cuba and Puerto Rico, and similar work in Alaska has been extended into the interior. The records of

temperature, pressure and humidity, secured at 17 stations where 1200 ascensions of kites were made, have been collated, giving for the first time in the history of meteorology a large number of facts as to the average gradient of temperature up to six or eight thousand feet "free from all injurious influences and for so many days and over such a large region of country that it has a broad significance."

The Division of Chemistry has made important additions to its investigations of soils, including methods of analysis, foods and sugar beets. A special line of work the past year has been the study of preservatives of all kinds which may be used on meats.

The Division of Entomology reports the successful importation of *Blastophaga grossorum* for the fertilization of the flowers of the Smyrna fig trees which are largely grown in California. The study of injurious insects that may invade our territory from contiguous countries has been continued. Investigations are being made regarding the transmission of disease by house flies and mosquitoes. The San José scale, Mexican boll-weevil and insects injurious to growing crops, grasses and tobacco are among the other subjects of investigation in this Division on which considerable progress has been made recently.

The Biological Survey has extended its work on life zones, specially on the Pacific Coast. Several life zones have been run from the bottom of the Sacramento and San Joaquin valleys to the summit of the Sierras. The collection of bird stomachs which this division has accumulated during the past 14 years, numbers 31,300 specimens, about 2000 of which were examined in the laboratory the past year. Considerable work has been done to determine whether birds show marked preferences in selecting food or simply eat what is most abundant.

The Division of Vegetable Physiology and Pathology has been studying diseases affecting timber, the 'little-peach' disease, pear blight, diseases of white and sweet potatoes, a fungus disease attacking sea-island cotton, peach leaf curl, and diseases of lemon, orange and walnut trees. This Division is doing much more work than formerly on the hybridization and breeding of plants, including oranges and other citrous fruits, raisin grapes, corn and wheat. It has also undertaken elaborate investigations in coöperation with the Division of Soils on curing and ermentation of tobacco. "It has been found that the flavor and aroma are due not to bacteria, as was formerly supposed, but to enzymes or oxidizing agents in the leaf itself. The formation of these oxidizing agents and the conditions of their greatest activity are being studied."

The Division of Pomology has continued experiments with a view to the successful production of the finer table grapes of Europe, and has also made investigations in root grafting.

The work of the Division of Forestry has been reorganized during the year. A large amount of practical advice and assistance is being given to farmers, lumbermen and others in handling their forest lands, in a number of different States. The rate of growth of the loblolly pine in North Carolina, and the red or Douglass fir in Washington, has been studied, as well as their special qualities in forestry. Forest fires have been studied historically, and in the field, and the records of more than 5000 fires have been compiled and classified. The Secretary urges that this division be given a largely increased appropriation "to take advantage of the unprecedented opportunities created by the rapid public awakening to the meaning and value of practical forestry."

The Divisions of Soils has considerably extended the investigation and mapping of

the alkali soils of the irrigated districts of the West. Special studies of alkali soils have been made in the Yellowstone Valley in Montana and Pecos Valley in New Mexico, and in the vicinity of Salt Lake City, Utah. Soil surveys of Maryland and of Louisiana have been undertaken in coöperation with local agencies. Investigations of tobacco soils have been extended.

The Division of Agrostology has continued its work on native and cultivated grasses and forage plants with reference to the needs of the arid and semi-arid regions of the West. Studies of plants suitable for binding sands along sea shores and about the Great Lakes have been made in different parts of the country. Several native sand-binders of great promise have been discovered and their utilization, in a practical way, has been undertaken.

The examination of the work of the agricultural experiment stations made by the Office of Experiment Stations shows that these institutions are being more and more appreciated by the farmers and are doing more thorough and satisfactory work.

"The relations of the Department of Agriculture to the experiment stations made by several States become closer every year. An increased amount of assistance is given every year to the State experiment stations to enable them to carry out work of a national character. Coöperative work between the Department and the stations is gradually increasing. The Department is consulted oftener regarding the organization and management of the stations, the choice of officers, the lines of work to be undertaken, the execution of special work, plans for station buildings, materials and apparatus required for use in connection with the different kinds of agricultural investigation, etc."

The need of the establishment of experiment stations in Puerto Rico, Hawaii and the Philippines is strongly urged, and an appropriation for this purpose is asked for. Satisfactory progress has been made in the establishment of experiment stations in Alaska. The investigations on human nutrition, in charge of this Office, have been continued under the direct supervision of Professor Atwater, with headquarters at Middletown, Conn., and a number of reports have been published. The organization and development of the irrigation investigations, also in charge of this Office, have rapidly proceeded during the past year, and work is now done in this line in fifteen States and Territories. Professor Elwood Mead, formerly State Engineer of Wyoming, has been in charge of this work, and headquarters have been regularly established at Cheyenne, Wyo. This work includes studies of the laws and administrative regulations in the irrigated region and investigations on the supply of water. The need and importance of this work are dwelt upon at considerable length by the Secretary, and its national aspects are pointed out.

The Office of Road Inquiries is working in coöperation with local authorities in building sample roads from the materials found in different localities and in the laying of steel track.

The Section of Foreign Markets has made special studies regarding the trade of the Philippine Islands, Puerto Rico and Cuba, and of Danish imports from the United States. The record for 1898 shows that our agicultural exports were decidedly the largest in the history of the country, their total value reaching over $850,000,000.

The meat inspection, conducted by the Bureau of Animal Industry, has reached very large proportions. During the past year it was conducted in forty-one cities, and the total number of ante-mortem inspections of animals was 53,223,176. Encouraging results have come from the efforts of the Department to increase the export of

dairy products. The investigations of the Bureau which have resulted in the preparation and distribution of serum for the prevention of hog cholera, swine plague, and blackleg have proved to be very successful. The loss from these diseases has been materially reduced when the treatment recommended by the Department has been followed.

The Division of Statistics has studied the condition of the agricultural industry of the country "as indicated by the area of land devoted to the cultivation of the principal products of the soil; the actual volume of production and the value of particular crops, both on the farm and in the principal markets; the cost of production per acre and per unit of quantity and the cost of transportation; the number and value of farm animals and the losses annually resulting from disease and exposure; the volume, condition and prospects, according to the season of the year, of such of the crops of foreign countries as compete with those of the United States in the world's markets."

The Secretary reviews at some length the subject of seed distribution. He warmly defends such distribution in so far as it adheres to the original intention of Congress, which was to search for and gather in various localities of the Old World useful seeds and plants to be distributed in the United States to the several regions where they would be most likely to succeed. The Department is at present endeavoring to bring back the practice as much as possible to this original intention, a larger per cent. of the $130,000 appropriated being now spent in securing, importing and distributing rare and useful seeds and plants.

The tea growing experiments in South Carolina are commended and their intelligent prosecution advocated. The interesting fact is noted that the tea gardens at Summerville produced 3,600 pounds of tea the past season. Irrigation experiments, improvement of varieties by importation and by hybridization, are indicated as important steps to be studied.

In regard to public lands, the Secretary deplores the ill results of injudicious grazing due to the indifference of the occupiers under the present system. He advocates leasing in large areas and for a sufficient time to invite improvement, and suggests that the revenue from such leases might be turned over to the States for educational purposes or irrigation.

The Secretary concludes his report with important recommendations on a variety of subjects.

Of the abandoned farms of New England he says that they are not abandoned on account of sterility; that they will be studied by the soil physicist, agrostologist, and the forester, and the valuable suggestions resulting from their studies will be distributed throughout New England.

He urges that means be adopted to produce in Puerto Rico, Hawaii and the Philippines many of the tropical plants which this country now imports to the extent of $200,000,000 annually—more than four times as much as the total exports of the islands in question.

Our import of oranges, lemons, cocoanuts, bananas, and especially coffee, of which in 1898 we imported over $65,000,000 worth, could, in large part, be produced in Puerto Rico. The Secretary especially recommends experiments in the production of india rubber, for which we are now largely dependent upon Brazil. The import of india rubber and gutta-percha in 1898 exceeded in value $26,000,000, of which three-fifths came from Brazil. After discussing at some length the methods of collection and treatment and the character of the Brazilian product, he indicates one tree in particular, known as the Ceara, as likely to be the first to produce an important addition to the natural supply of

india rubber. He adds: "The feasibility of cultivating this plant in the Philippines should be very carefully investigated."

The Turkestan alfalfa introduced by the Department is warmly commended as successfully withstanding drought and cold. It is proposed to distribute it widely over the arid West, to be thoroughly tested, and its introduction is spoken of as likely to add millions of dollars to the annual hay product of the country.

A valuable rice has also been introduced from Japan. It possesses a high milling quality and is highly superior to the domestic product, and should it succeed in Louisiana, hundreds of thousands of dollars will be added yearly to the rice-growing industry.

In connection with the subject of native drug plants, coöperative work is proposed by the Department and the Pan-American Congress in a technical and scientific investigation of these plants; $10,000 is asked for to enable the Department to undertake this work. The great increase of cotton imports from Egypt, averaging in value for the past three years nearly 3¾ million dollars, lends importance to the experiments so far made with the Egyptian cotton seed imported by the Department in 1894. While a further trial is needed, hope is expressed, that with proper management, it will become well established in the United States.

Mr. Wilson makes a most urgent plea for the erection on the Department grounds of new laboratory buildings as a substitute for the numerous and inconvenient buildings, mostly dwelling houses, now occupied for laboratory purposes at a cost of $10,000 a year. He has caused plans to be prepared of fireproof structures providing an increase of floor space over the present accommodations and in every way more suitable and economical, to cost, approximately, $200,000.

The concluding portion of the report is devoted to a discussion of agricultural education. The Secretary holds that in view of the importance of agriculture in the economic life of the country, adequate measures for the efficient agricultural education of our people, nearly one-half of whom are engaged in agriculture, are lacking. He refers to the impossibility of securing, on demand from the Civil Service Commission, persons qualified to serve as assistants in the scientific Divisions of the Department. The training of the necessary experts has to be done in the Department itself, and then when their full measure of usefulness is attained, wealthy institutions take them from the service by offering much higher salaries than the Department is authorized to pay.

Arrangements have been made with the Civil Service Commission to make a register of the graduates of the land-grant colleges. From this register young men will be selected to assist in the scientific divisions at very small pay, but with special opportunities for post-graduate study such as no university in the land supplies. By this means it is hoped that the Department will have a force from which not only to fill vacancies when wealthy institutions take away the Department's trained men, but possibly, also, to supply agricultural stations and other scientific institutions with men of superior scientific attainments. This is a step intended to complete the educational system provided in the endowment of agricultural experiment stations and agricultural colleges. The work so proposed will entail but moderate expense, and the Secretary expresses the hope that it will meet with the approval of Congress. Reference is made to the gratifying evidence of growing interest in the subject of elementary instruction in sciences relating to agriculture, and to the progress made in this regard since the Secretary presented his last Annual Report.

During the year the Department issued

603 publications, aggregating 26,240 pages. The total number of copies was over 7,000,000; 4,000 volumes were added to the Department library.

SCIENTIFIC BOOKS.

Die Landbauzonen der aussertropischen Länder. By TH. H. ENGELBRECHT. Three volumes. Berlin, Dietrich Reimer (Ernst Vohsen). 1898. Royal 8vo.

These stately volumes were prompted, as the author's preface states, primarily by the question of American competition with European production; certainly a most timely topic. Vol. I., of 290 pages, contains the explanatory text for the other two, of which one consists of statistical tables of production, while Vol. III is an atlas of 79 colored maps, the graphic representation of results of comparisons made upon a basis somewhat different from the usual ones of total, or cultivated areas, or population. The author's object is to elicit the peculiar tendencies of agricultural production rather than its absolute quantities, and by the discussion of the causes of these tendencies to forecast present and future possibilities. He objects to the method of computation o the 'importance' of the several crops devised by Walker (amount produced divided by area population) as affording no definite clew to any inquiry as to causes.

Adopting for the extra-tropical countries the cereal grains as the fundamentally important product, Engelbrecht compares with the total area occupied by these, both those occupied by each individual kind, and by other crops. Correspondingly, in treating of the animal industries, he assumes neat cattle as the basis of comparison with other domestic animals. On the maps these comparisons are made by means of five, or at times six, shades of color, to which are frequently added important (mostly monthly) isotherms, as well as colored limiting-lines of the occurrence of important trees, of excess of production of one product over another, of limited special cultures, etc., whereby the comparisons are greatly facilitated and many interesting points are brought out. Thus, in Russia, the marked coincidence of the northern limit of the oak forest and of wheat culture is shown; in the United States, the limits between predominance of summer and winter wheat, of rice over wheat culture, etc.

For the Old World, where changes are very slow, the latest census has, as a rule, been utilized, and as there no uniformity of dates exist among the various states, the data represented are frequently of different dates. From the cause just mentioned these discrepancies are of minor importance; yet in the more progressive countries the establishment of new trade routes and connections following lines of railroads and steamships has even in Europe, in many instances, been followed by rapid changes in lines of production. In the case of the United States, with the rapid changes both in population and routes of communication, the comparison or several successive enumerations is given by means of tables.

In the Old World the maps are made to extend to the Ural mountains on the east, and southward so as to embrace Algeria and Tunisia. In America the map colors for the cereals reach a short distance only into Canada; for other products the Dominion is left in blank, although quite fully represented in the tables of Vol. II. In South America the Argentine Republic is included in the graphic presentation, as are, in Australia, the temperate culture belts of the east and west coasts. Cape Colony is also considered in the matter of animal industry.

In the United States the smallest units considered are the single States. In Europe the smaller administrative units—departments in France, 'governments' in Russia, in England, counties, are separately colored on the maps and listed in the tables; the results of several census periods are frequently given, both in tables and maps, and numerous minor cultures are included in detail.

Accustomed as we are to interpret intensity of coloration in statistical maps as a measure of absolute production, at first sight these maps strike one rather oddly. Thus when Ireland and western Lapland bear the same color in respect to the production of the potato, and Nevada and Arizona appear most intensely colored on the score of the production of barley, our geographical and economic consciousness is

shocked. But when we find that, rightly interpreted, these colors mean that in these cases the crops mentioned occupy areas in the ratio of 40% and 30%, respectively, to the total area of grain culture, we obtain unexpected information of a very definite character, which is at once complemented by an inspection of the maps showing the ratios of other crops, into a very fair picture of the agricultural adaptations and possibilities of these unfamiliar regions. On the map of Europe, we at once see the predominance of the most rapidly maturing grain, barley, in the north, while to southward oats become predominant, and finally maize. The discussion in Vol I. of the complex topographic, climatic, ethnologic and commercial conditions which bring about the existing state of production in the various countries included, is able and very interesting. But the author does not, apparently, trust himself to make any definite summary forecast of the future development of competitive production as between Europe and America; doubtless because in the detailed discussions he finds the determining factors to be numerous and so complicated with unforeseeable contingencies, especially in view of the phenomenal progress of transportation facilities and other consequences of industrial and technical progress, that he rests content with the presentation to the student of economics of a host of valuable facts and suggestions from which he may draw material for his own conclusions. It is noteworthy that, as the author admits, the United States maintains the most complete system of statistical enumeration, and thus, despite the mutability of its population, supply already at least as complete a picture of the climatic adaptations of production as does the more ancient but politically disjointed continent of Europe, with its multifarious methods of enumeration and numerous artificial barriers to development.

Engelbrecht's work is certainly of high interest to all students of the economics of agricultural production and commerce; and should find a prominent place in public libraries especially.

E. W. HILGARD.

Plant Relations. A first book of Botany. By JOHN M. COULTER, A.M., Ph.D., Head Professor of Botany in the University of Chicago. Twentieth Century Text-books. New York, D. Appleton & Company. 1899. Pp. ix + 264. 12mo.

In this pretty book, with its beautiful illustrations, the author presents 'a connected, readable account of some of the fundamental facts of botany,' in such a form as 'to give a certain amount of information.' The phase of botany to which attention is directed, is mainly that which in these later years we are calling ecology, and which hitherto has, to a large degree, been reserved for the later years of study in extended botanical courses in our universities. Dr. Coulter believes that the ecological view of the plant kingdom gives a proper conception of the place of plants in Nature, and is of more value to those who give but little time to the subject, while it serves as a fitting foundation for subsequent botanical studies.

After a short introductory chapter the foliage leaf is taken up and studied as an organ of the plant whose position, color, shape and structure are controlled by its light relations. The reader's attention is directed to many interesting phenomena, as the diurnal positions of leaves, sensitiveness of leaves, polarity, heliotropism, the relation of leaves to one another on erect and horizontal stems, etc. In the next chapter this is continued in a brief and summary discussion of the functions (photosynthesis, transpiration and respiration) and structure (gross structure, epidermis, stomata, mesophyll and veins) and protective devices (hairs, diminution of surface, rosette arrangement, profile position, etc.) of foliage leaves. Then follows a chapter on shoots, noting stems bearing foliage leaves (subterranean, procumbent, floating, climbing and erect), stems bearing scale leaves (buds, tubers and rootstocks), stems bearing floral leaves (life relations, structures, sepals, petals, stamens, etc.), and very briefly the structure of stems (dicotyledons and conifers, monocotyledons, ferns and 'lower plants'). In the chapter on roots the treatment is much the same (soil roots, water roots, air roots, clinging roots, prop roots, parasites, and a page on root structure). The reproductive organs are discussed under vegetative multiplication, spore reproduction, germination, dispersal of repro-

ductive bodies (by locomotion, water, air, forcible discharge, larger animals and insects). In like summary and interesting fashion the relations of flowers and insects are pointed out, the treatment being much too brief for the average reader with the limited acquaintance with flowers and flower structure which he is supposed to possess.

Half a dozen pages are given to a discussion of the struggle for existence among plants, the factors noted being decrease of water and light, changes in temperature and soil composition, devastating animals, plant rivalry, adaptation, migration and destruction. A dozen pages are taken up with the nutrition of plants, the principal topics being photosynthesis, the manufacture of proteids, digestion (14 lines), assimilation (5 lines), respiration and 'carnivorous plants.'

The remaining chapters (XI. to XV.) are given to a discussion of plant societies, in which the factors (water, heat, soil, light and wind) are first pointed out, followed by citations of examples of hydrophyte xerophyte, mesophyte, and halophyte societies, with suggestions as to their significance. Throughout the book the illustrations are superb, and add much to its value and interest.

As a summary of the ecological view of plant life for those already well grounded in botany, the book leaves little to be desired. It will be profitable reading for the student who has had what may be called General Botany in colleges and universities, but as a first book to be used by pupils in the secondary schools it will prove to be too difficult where thoroughness and accuracy are desired, otherwise it will be found too superficial. As a book for secondary schools it calls the attention of the pupil to many interesting phenomena, whose significance he can but vaguely comprehend because of his unfamiliarity with different types of plants. It is probable that the author recognized some of these difficulties after completing the book, as in the accompanying pamphlet of 'suggestions to teachers,' he says (p. 3) "if there has been no previous study of plants it will be necessary for the teacher at the outset, to train the pupils to recognize the great groups. This may be done in a series of laboratory exercises, which include comparison and drawing." Any teacher who has tried it, will say that the training of pupils 'to recognize the great groups' of plants ('algæ, mushrooms, lichens, mosses, ferns, gymnosperms, monocotyls and dicotyls, and if possible, liverworts, equisetums and club-mosses') is a pretty large undertaking for a half year's work, and if done well there will be little time left for the subject-matter of this book. Thus the author's own suggestions require a previous study of plants, and the book is therefore *not* a 'first book of botany.'

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, October. 'On Potassium Cyanide as a Condensing Agent,' by A. Smith; 'Camphoric Acid,' by W. Noyes; 'The Action of Bromine on Metachlor-, Metabrom-, and Metaiodanilines,' by H. L. Wheeler and Wm. Valentine; 'A Simplification of Beckmann's Boiling-point Apparatus,' by S. L. Bigelow. The liquid is heated by passing a current of electricity through a platinum wire immersed in the liquid. 'A Contribution to our Knowledge of Dicarbonyl Cuprous Chloride,' by W. A. Jones.

November: 'The Rate of Action of Water on Certain α-, β-, and γ-Halogen Substituted Fatty Acids,' by E. De Barr; 'The Occlusion of Hydrogen by Metallic Cobalt and other Metals,' by G. P. Baxter; 'On the Nature of the Oxyazo Compounds,' by W. McPherson; 'A Contribution to the Study of Liquid Mixtures of Constant Boiling-point,' by G. Ryland; 'The Action of Benzoyl Chloride on the Phenylhydrazones of Benzoin,' by P. C. Freer; 'Notes on the Space Isomerism of the Toluquinoneoxime Ethers,' by W. C. Morgan; 'A Dissolver,' by A. J. Hopkins. The author has devised a simple device for rapidly dissolving salts. J. E. G.

IN *The American Naturalist* for November, J. H. Comstock and J. D. Needham continue the series on 'The Wings of Insects,' with an interesting account of the development of wings containing a discussion of the origin of the tracheation of the wing. 'A Contribution to the Morphology of *Pennaria tiarella*' McCrady,

is furnished by Martin Smallwood, who also discusses the development of the Medusa and the origin of the sex cells. The Medusæ of *Pennaria* are considered to be in a degenerate condition. The 'Reversal of Cleavage in *Ancylus*' is described by Samuel J. Holmes, who considers that it has a special significance from the fact that the left-handedness of this genus has probably arisen independently of that of *Physa* and *Planorbis*. The 'Synopses of North American Invertebrates' is continued by C. H. Turner, who furnishes a 'key to the Fresh-Water *Ostracoda*.' In the Reviews of Recent Literature, zoology claims an unusually large share.

THE *Journal of the Boston Society of Medical Sciences* commences its fourth volume with the October number. Under the title 'Recent Additions to the Warren Museum of the Harvard Medical School,' Thomas Dwight describes briefly a series of interesting abnormal human backbones. G. Hay discusses 'A Curious Relation between the Positions, as given by Dr. Weiland, of two Linear After-Images, studied in connection with the Law of Listing, and the Corresponding Angles of two Pairs of Great Circle Planes, as given by Helmholtz.' J. H. Wright contributes three beautiful plates showing a number of 'Photographs of Malarial Parasites.'

SOCIETIES AND ACADEMIES.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE October meeting of the New York Section of the American Chemical Society was held on Friday evening, October 6th, at the Chemists' Club, 108 West 55th Street.

The following papers were read:

'Some Notes on the Year's Progress in Applied Chemistry,' by William McMurtrie.

'Filters for Purifying Public Water Supplies,' by Allen Hazen.

'The Mordanting and Dyeing of Silk,' by Rafael Granja.

Robert Wilhelm Eberhard Bunsen, In Memoriam. A Tribute from former Pupils.

Dr. Doremus asked for original papers for presentation at the conference to be held in Paris next August.

The question of holding an extra meeting in November was discussed, but no final action taken.

E. E. SMITH,
Sec'y Pro. Tem.

THE regular meeting of the Section was held in the assembly room of the Chemists' Club, 108 West 55th Street, on Friday evening, November 10th. Sixty members were in attendance, Dr. C. T. McKenna presiding. The following papers were read:

1. Wm. McMurtrie, 'Some Notes on the Year's Progress in Applied Chemistry.'

2. M. Trubek, 'The Technical Analysis of Licorice Paste.'

3. P. A. Levene, 'On the Chemistry of Mucin.'

Dr. McMurtrie's continuation of his paper on the year's progress in applied chemistry was full of valuable material, and covered a wide range of subjects, among them the electrolytic production of alkali, the production of ozone on a large scale for bleaching oils and purification of water, improved shorter methods for manufacture of white lead, and a very full comparison of the efficiency of different gases and gas burners, as well as recent experimental work on the cause of light in the Welshbach mantle, and the best mixtures for the purpose.

It is expected that this paper will be published in full.

The question of a joint meeting with the Philadelphia Section was brought up by the Chairman, who stated that it had been decided to postpone the proposed meeting until after the holidays.

DURAND WOODMAN,
Secretary.

THE WASHINGTON BOTANICAL CLUB.

THE tenth regular meeting of the Club was held at the residence of Mr. C. L. Shear, October 4, 1899. The evening was devoted to informal accounts of the season's work in the field. Mr. Shear described his investigations on the coast of Oregon and Washington, where he was engaged more particularly in studying the sand-binders. *Carex macrocephala*, *Poa macrantha*, and *Elymus arenarius*, he stated, were the best examples of this class of plants in that region. Mr. Pieters spoke of the peculiar conditions of plant growth in the lake district of Central Florida, each variety of soil yielding a different

class of species. Mr. Pollard briefly described a short collecting trip in West Virginia and Virginia.

THE eleventh regular meeting was held at the residence of Mr. C. L. Pollard, November 1, 1899. The election to active membership of Mr. William R. Maxon, of the United States National Museum, was announced. Mr. C. L. Shear spoke of his discovery of a truffle, *Terfezia oligosperma*, in Maryland, stating that this was the first record of its appearance in the United States. His remarks were illustrated by specimens and by microscope slides. Mr. J. N. Rose described the mescal industry of Mexico, exhibiting photographs of the mescal plant itself and of the mode of preparing the liquor, a sample of which was passed around among the members. Mr. L. H. Dewey gave an account of various weeds observed by him on a trip through the southern states during the past summer; the most prevalent species, he considered, were the following: *Leptilon divaricatum*, *Diodia teres*, *Cassia occidentalis*, *C. Tora*, *Helenium tenuifolium*, *Croton capitatus*, and *Solanum rostratum.* Mr. Pollard exhibited the first decade of a distribution of North American Violaceæ undertaken by Professor Greene and himself. Professor John M. Coulter, of the University of Chicago, who was present as a guest of the Club, gave a short address on the organization and aims of the department of botany in that institution.

CHARLES L. POLLARD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE SCIENCE OF METEOROLOGY.

TO THE EDITOR OF SCIENCE: In reading the admirable address by Dr. Marcus Benjamin, in your JOURNAL of November 3d, it occurs to me that the learned Doctor is rather hard on meteorology when he speaks of "*that science which we now dignify by the name of meteorology*" (see page 628). Are we to understand that this science has recently been dignified by giving it this new baptismal name? Have we of the present generation devised this dignified name for a new branch of science? My understanding is that meteorology as a branch of philosophical study is quite as old as astronomy, if not older, and that the name 'meteorologia' originated with that profound school of philosophy of which Plato and Socrates were the expounders. To them, or possibly even to their predecessors, we owe the system of nomenclature 'astronomia,' 'meteorologia,' 'geometria,' etc., by which they designated the various branches of knowledge. Doubtless, Dr. Benjamin meant to refer to 'that science which Plato and Socrates dignified by the name of meteorology.' The correction is worth making in order that your readers may not forget that the study of the atmosphere has from the most ancient times been recognized as a distinct branch of science.

C. A.

NOTES IN PHYSICS.

THE MAGNETIZATION OF LONG IRON BARS.

DR. C. G. LAMB, in the *Philosophical Magazine* for September, gives some interesting experimental results concerning the distribution of magnetic induction along a long cylindrical iron rod. When the rod is weakly magnetized, the mean positions of its poles are comparatively near the ends of the rod; with stronger magnetization the poles move farther from the ends; and with very strong magnetization the poles move more and more towards the ends. This result, as Dr. Lamb points out, has important bearing upon the magnetic testing of iron by Ewing's method.

THE VELOCITY OF THE CHARGED AIR PARTICLES NEAR A DISCHARGING METAL POINT.

PROFESSOR A. P. CHATTOCK in the *Philosophical Magazine* for November, gives the results of a very ingenious determination of the velocity of the charged air particles or *ions* in the electrical discharge from a metal point. He finds the velocity to be 413 centimeters per second for positive ions, and 540 centimeters per second for negative ions, both for an electric field of 300 volts per centimeter. This result is in remarkable agreement with the velocities of the air ions which are produced by X-rays and by uranium radiations. Professor Chattock also shows that the velocity of the wind which blows from a discharging point is not greater than 2 per cent. of the velocity of the ions, and

he estimates that these ions are molecular aggregates of about 8000 ordinary molecules each. This estimate of the mass of the ions is, of course, based upon data not altogether satisfactory.

THE RESPIRATION CALORIMETER AT MIDDLETOWN, CONN.

PROFESSORS ATWATER AND ROSA give, in the *Physical Review* for September and October, a very complete description of the calorimeter chamber which they are using at Middletown in their interesting experiments upon energy transformations in the human body.

THE COMPENSATED ALTERNATOR.

THE alternating current dynamo, when used to supply current to lamps only, or to one type of electric motors only, may be made to give constant electromotive force by providing a compound field winding. When, however, an alternator supplies current in varying amounts to lamps and to motors simultaneously, the electromotive force cannot be kept constant by compounding. One of the most interesting of recent improvements in the alternator is that of E. W. Rice, Jr., of the General Electric Company. The alternator and exciter are mounted on the same shaft, and the alternating currents pass through the exciter armature on their way to the mains, causing such variations of the electromotive force of the exciter as to compensate for all kinds of variations of load on the alternator. This new alternator is described in the *American Electrician* for November.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

A PAPER has been lately issued by the Wisconsin Academy on the influence of the presence of pure metals upon plants, by E. B. Copeland and L. Kahlenberg. It is a complete refutation of the theory of Nageli of the oligodynamic effects of metals upon plants, which is that where a plant is growing in water, in contact with a metal as copper, a trace of copper goes into the solution as a metal and produces a toxic action very different from that produced by a salt of copper in solution. In the experimental portion of the work of Copeland and Kahlenberg, plants (corn, oats, lupines and soja beans) were grown in water in paraffin coated glass beakers, in which were exposed as nearly as possible the same surfaces of different metals. Twenty-five or more elements were tested, and while at the end of the experiment many of them were scarcely tarnished, most showed themselves to have had some influence upon the plant used. Comparing with the sequence given by Neumann of elements arranged according to their surface tensions—magnesium, aluminum, manganese, zinc, cadmium, thallium, iron, cobalt, nickel, lead, hydrogen, bismuth, arsenic, antimony, tin, copper, mercury, silver, palladium, platinum, gold—all of these elements down to mercury, except aluminum, tin and magnesium, are injurious, and excepting further manganese and bismuth, fatal during the time of the experiment. Mercury and silver were sometimes injurious, palladium, platinum and gold never. Regarding aluminum and magnesium, their salts are comparatively harmless. Comparing their results with the known toxicity of the salts of the corresponding metals, the authors conclude that the poisonous action is due to the solution of the metal in the form of a salt and not to an action of any other nature. The paper gives an interesting summary of our knowledge on the toxicity of metals toward plants, and has also a bibliography of the subject.

IN a paper on the heat of combination of copper with zinc, presented to the Chemical Society (London), Dr. T. J. Baker makes use of chlorin water and of HNO_3, $3H_2O$ as solvents of the brass. Up to 30% copper no heat of formation could be detected; it then begins and rises to an ill-defined maximum at 62% copper, and then gradually sinks to zero at 100% copper. This alloy of 62% copper, while possessed of somewhat remarkable properties, does not correspond to any simple atomic compound ($Cu_5Zn_3 = 61.8\%$ copper); the existence of the supposed compound $CuZn_2 (= 32.6\%$ copper) is rendered doubtful from the fact that the alloy of this proportion shows almost no heat of formation.

FURTHER researches on radiant matter in pitch-blende have been made by A. DeBierne,

and are published in the *Comptes Rendus*. Polonium, already found by Curie, seems akin to bismuth and radium to barium. DeBierne has worked upon that portion of the solution of pitch-blende which is not precipitated by hydrogen sulfid in acid solution, but is by ammonia or ammonium sulfid. In this portion were present with iron and aluminum small quantities of many other metals, as zinc, manganese, chromium, vanadium, etc., and rare earths. A new radiant substance was found closely akin analytically to titanium, whose power is 5000 times as great as that of uranium, but is not spontaneously luminous as in the case with radium.

In the *Zeitung für Biologie* H. Harms has gone over again the question of the quantity of fluorin in bones, and his conclusion is that the amount varies from 0.005% to 0.022%, and that the quantity is so small and variable that it must be considered, not as belonging to the constitution of the bones and teeth, but as merely accessory.

It has long been believed that the step from the inorganic carbon dioxid and water to organic plant substance, that is to the carbo-hydrates, was by way of formaldehyde, but the actual existence of the intermediate product could not be proven. By macerating fresh leaves with pure water and immediately distilling, it has been possible for Gino Pollacci to detect formaldehyde in the distillate. The test used for formaldehyde is the violet color given with codein and concentrated sulfuric acid.

A notable contribution to the stereo-chemistry of nitrogen by W. J. Pope and S. J. Peachey appears in the last Proceedings of the Chemical Society (London). When α-benzyl-phenyl-allyl-ethyl ammonium iodid is heated with silver dextro-camphorsulfonate, it is resolved into optical isomers, respectively dextro- and levo-rotary. Here the optical activity appears to be clearly due to the asymmetry of the quinquevalent nitrogen atom, linked to five different groups (or atoms). When the paper was read, Dr. Armstrong characterized it as being the most valuable contribution to stereochemistry since the introduction of geometrical considerations by Le Bel and van't Hoff. J. L. H.

SCIENTIFIC NOTES AND NEWS.

Memorial exercises in honor of the late Edward Orton were held at the Ohio State University on November 26th. Addresses were made by President T. C. Mendenhall, Dr. G. K. Gilbert, Hon. T. J. Godfrey, Professor W. H. Scott and Professor S. C. Derby.

The bacteriologists of America are planning to organize a society to meet during Christmas week in affiliation with the American Society of Naturalists. The first meeting for organization will be held at New Haven during the coming holidays. A program of papers has, however, been provided, and all interested in bacteriological topics are invited to attend. Information in regard to the Society may be obtained by addressing Professor H. W. Conn, Middletown, Ct.

Dr. William R. Brooks, director of Smith Observatory, has just been awarded by the Paris Academy of Sciences 'the Grand Lalande' prize for his numerous and brilliant astronomical discoveries.

Professor Charles R. Cross of the Massachusetts Institute of Technology will give a series of Lowell lectures on 'The Telephone,' beginning on December 19th.

A dinner given by the Physical Society, London, was held at the Hotel Cecil on November 17th. The president of the Society, Professor O. J. Lodge, took the chair, and the guests included Right Hon. A. J. Balfour, Mr. G. Wyndham, M.P., Sir W. H. Preece, Major-General E. R. Festing, Dr. J. H. Gladstone, Professor A. W. Rücker, and Professors G. F. Fitzgerald, A. W. Reinhold, A. W. Ayrton, S. P. Thompson, G. C. Foster, and W. Ramsey.

A totemic column from southern Alaska has been presented to the museum of the University of Michigan by Leon J. Cole, assistant in zoology, who visited Alaska last summer as a member of the Harriman Alaska Expedition. The column is about ten feet high and three feet wide and is made from a tree trunk split lengthwise. It was taken by Mr. Cole from the interior of a house in a deserted village of the Tlingit Indians near Cape Fox.

DR. HENRY HICKS, F.R.S., died, near London, on November 18th aged sixty-two years. His father was a surgeon and he was himself a physician, being a specialist in mental diseases. He was, however, best known as a geologist, having contributed many important papers on geology and paleontology. He was secretary of the Geological Society from 1890 to 1893, and president from 1896 to 1898.

PROFESSOR JOHANN CARL WILHELM FERDINAND TIEMANN died of heart disease at Meran on November 13th, aged fifty-one years. He became a Ph.D. of Göttingen in 1870, and in 1882 was appointed professor of chemistry in Berlin University, undertaking from the same date the editorship of the proceedings of the German Chemical Society. Professor Tiemann was the author of numerous important researches having for their object the discovery of the constitution of the camphors, the terpenes, and other organic bodies. As a result of his work in theoretical chemistry, the manufacture of artificial flavoring matters and perfumes resulted, which is now an important German industry. Professor Tiemann was a brother-in-law of the eminent chemist A. W. von Hofmann.

THE death of Dr. Camara Pestana at Lisbon on November 15th, adds, says the London *Times*, another distinguished name to the list of martyrs to science. He caught the plague while studying the disease at Oporto. Dr. Pestana was chief of the Bacteriological Institute at Lisbon, a man in the prime of life, an ardent and most accomplished bacteriologist. It was his verdict on specimens sent him from Oporto for examination that conclusively established the existence of the plague there in August last. He paid several visits to Oporto to study the outbreak, and was present there when the foreign representatives of science visited the city. His courtesy and amiability greatly endeared him to all his colleagues, while his scientific attainments commanded their respect. His contributions to bacteriology, being written in Portuguese, are but little known, and the foreign bacteriologists visiting Oporto only then became acquainted with them for the first time. They were not less surprised than delighted with the originality and brilliancy of Dr. Pestana's work, and several of them expressed the opinion that if he had used a different language he would undoubtedly have enjoyed the European reputation which his researches deserved. He will be deeply and sincerely regretted.

SIR RAWSON WILLIAM RAWSON, died, in London, on November 20th in his 88th year. He was formerly vice-president of the board of trade and Governor of Barbados, but was interested in scientific matters, having been a member of the council of the Geographical and Statistical Societies, and president of the latter. He was the first president of the International Statistical Society established in 1885, and held this office for ten years.

THE death is announced of Mr. William Pamplin at the advanced age of ninety-two years. He was elected an associate of the Linnæan Society in 1830, and made various contributions on the geographical distribution of British plants.

THE death is also announced of Professor Spirgalis, for thirty years director of the laboratory of pharmaceutical chemistry at Königsberg.

A COLOSSAL bronze statue in honor of Ferdinand de Lesseps was unveiled at Port Said on November 17th. Among the addresses was one by Vicomte Melchior de Vogüé, representing the French Academy, who testified to de Lesseps's services to art and science and especially to his indomitable energy.

THE Parliament of Queensland has voted £1,000 towards the funds of the British Antarctic expedition.

THE American Society of Mechanical Engineers is holding its meeting in New York during the present week.

THE third International Congress of Photography is to be held in Paris from July 23 to July 28, 1900. The General Secretary is M. S. Pector, 9 Rue Lincoln, Paris.

IN accordance with the policy of the War Department for a systematic co ection of as many interesting relics from Cuba, Puerto Rico and the Philippines as possible for exhibition in

Washington, Major General Brooke, commanding the division of Cuba, has issued the following circular to the officers serving on that Island:

"Officers of the army serving in Cuba are requested to procure wherever practicable any object of historical, ethnological or artistic interest that it may be possible for them to obtain in a proper manner for shipment by government transports, to be deposited among the government collections in the Smithsonian Institution at Washington."

The Indian correspondent of the *British Medical Journal* reports that the Muktesar Bacteriological Laboratory, including the residence of the Imperial Bacteriologist, which formed part of it, has been completely gutted by fire. Owing to the large amount of pinewood which had been used in the construction of the building, including an enclosed wooden veranda on either side, the flames, which broke out at night, aided by a strong wind, spread with such rapidity that much of the laboratory apparatus, and nearly all private property, was lost. It is stated, however, that the whole of the records of the rinderpest experiments which have been carried out throughout the present year, together with efficient apparatus to allow of their being continued, and all the Government library, have been saved. Surgeon-General Harvey will visit Muktesar early in November, when it is expected that arrangements will be made for the reconstruction of the building, as the walls are reported to be sound.

UNIVERSITY AND EDUCATIONAL NEWS.

The University of Pennsylvania has received a gift of $250,000 for the construction and equipment of a laboratory of physics, which will be erected at Thirty-fourth and Locust streets. The name of the donor is withheld for the present.

It was announced in this Journal last week that funds had been provided for a chair of geology in McGill University in memory of the late Sir William Dawson, the income to be given to Lady Dawson during her life. At the last meeting of the Governors of the University, it was announced that the donor is Sir William MacDonald, to whom the University is already indebted for such great gifts. The amount of the endowment is $62,000 and the chair is to be known as the Dawson chair of geology. There is already a Logan chair of geology in the University, filled by Professor Frank D. Adams, but a second will be filled when the income becomes available.

Wesleyan University has received a gift of $38,000 from Miss Elizabeth A. Mead, subject to an annuity during her lifetime. St. Lawrence University has received $34,000 from various sources. North Western University has received $15,000 from Dr. R. D. Sheppard toward the cost of a gymnasium.

Hon. Wm. C. Todd, of Atkinson, N. H., the founder of the newspaper reading room of the Boston public library, has just made the gift of $500 to the library of Washington and Lee University, to be used chiefly for books on chemistry.

It is probable that a college for teachers will be established at Cornell University with the aid of funds from New York State. By the increase in the number of the assembly districts in the State, Cornell University must educate eighty-eight additional students without charge, and it is reported that President Schurman and the Superintendent of Public Instruction have asked for support for the college for teachers in return for these scholarships. The College will be on the same basis as the State Veterinary College and the State College of Forestry, in which the cost of professional training is provided by the State, and the other instruction by the University.

A university Council has been established at Yale University, the function of which is specially to consider questions which concern more than one school or department. The first members are Dean Wright and Professors Dana, Perrin and Sumner of the academic department; Dean Chittenden and Professors Lounsbury and Pirsson of the Scientific School; Dean Phillips of the Graduate School; Dean Wayland and Professor S. E. Baldwin of the Law School; Dean Smith and Professor Carmalt of the Medical School; Dean Fisher and Professor Brastow of the Divinity School; Dean Weir of the Art School, and either Professor Parker or Professor Sanford of the musical department.

SCIENCE

FRIDAY, DECEMBER 15, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REMINISCENCES OF BUNSEN AND THE HEIDELBERG LABORATORY,

1863–1865.

I FIRST met Bunsen in the lovely, retired valley of Engelberg, Switzerland, during the summer of 1863; I had spent the preceding twelve months in Paris, working in Dumas' laboratory at the Sorbonne, and in the *École de Médecine* under Wurtz, and was expecting to continue my studies in Heidelberg. Learning by accident that Bunsen was at an adjoining *Gasthaus* I called on him and told him of my plans; he received me graciously and immediately won my heart by his affability, by the charming smile that lit up his large features, and by his unselfish interest in my personal affairs. Being myself quite ignorant of the German language we conversed in French, and he gave me useful hints as to the opening of the University laboratory.

My first *semester* at Heidelberg was devoted almost exclusively to laboratory work, but I attended Bunsen's lectures on general chemistry every morning at nine o'clock in the adjoining auditorium. Bunsen's habit of saying one word when he meant to use another was at first puzzling, particularly as I was very weak in German, but when he exhibited the violet vapor of iodine and called it chlorine, my previous knowledge of chemistry assisted comprehension. After every lecture Bunsen rarely missed spending several hours in the laboratory, going

from student to student with enquiries, suggestions and useful hints. Desirous of securing my share of this personal contact I soon found the best way to induce the Hofrath to linger was to have a supply of clean test-tubes and beakers on an orderly desk, with a query or two requiring experimental answers. Any suggestion as to the use of the spectroscope in connection with a substance under examination was sure to interest the Professor, as that famous instrument was a comparatively new adjunct to chemical work, being then about four years old.

When in the laboratory Bunsen habitually carried between his lips a short, unlighted cigar, and he often stopped at a student's desk only long enough to light the tobacco at a 'Bunsen Burner'; in a few minutes the cigar was again without a spark owing to his absent-minded neglect to pull on it. Absent-mindedness was a marked trait in Bunsen's character, and many amusing anecdotes are told of the difficulties it brought him. The statement that he remained a bachelor because he forgot his wedding day is, of course, apocryphal, as is the other about his putting on a suit of garments on the top of others that he had forgotten to take off; but the following came under my personal observation. Bunsen used to dine every day at a little table reserved for him in a restaurant connected with the hotel in which I lived; one spring he fell into the habit of ordering veal-cutlets and asparagus as the chief item for his meal, and without reflection or feeling that a change of diet would be agreeable, he continued to order '*Kalbs-Cotelette und Spargel*,' daily for several weeks, until one day the *Kellner* gravely informed him that asparagus was no longer in season and could not be supplied. Bunsen seemed to be immensely taken a-back and to realize for the first time that he had been dining on one dish for a long period; he soon recovered himself, however, and asked the waiter for the bill-of-fare, from which, after careful examination, he ordered mutton-chops and peas, and this was his daily diet up to the time I changed my hotel.

When the laboratory was closed for the Christmas holidays I tried to get permission to work in the deserted rooms, but in vain, and not wishing to be idle I worked at growing crystals, improvising a desk out of a hotel wash-stand, and a heater out of the huge porcelain stove. Some time after I showed to Bunsen a single crystal of copper-calcium acetate about three inches long, with perfectly regular facets, and of which I was quite proud; he looked at it rather solemnly, as I thought, and enunciated the single word '*ausgezeichnet*'! This was not in my limited vocabulary and whether a commendation or a disapproval I could not divine; I puzzled over the word all day, and on returning home the dictionary explained its meaning to my great satisfaction.

As my knowledge of German increased I attended the lectures of Kirchhoff and of Kopp, but never was able to *enjoy* the latter's interminable sentences and involved style.

Bunsen's assistants in the laboratory at the time of my sojourn were Dr. Bender and Dr. Rose; the latter had the reputation among the students of giving more accurate instruction in mineral analysis than Bunsen himself. Rose is now professor in the University of Strassburg.

Bunsen's methods in mineral analysis were not wholly approved by the students; one day he stopped at my desk for a moment, and picking up a filter containing a moist precipitate he inquired: "What have you here?" Seeing with consternation a portion of my *quantitative* precipitate sticking to his thumb, I hastily seized a '*Spritz-Flasche*,' and washed the substance off his thumb into the filter on the funnel before venturing a reply. Bunsen smiled genially and passed on to my neighbor.

Bunsen showed extraordinary callousness to heat, being able to hold in his fingers metal nearly red hot; on one occasion when stirring a glowing crucible with a very short spatula, his skin fairly sizzled and for relief he took hold of the lobe of his ear with his smoking thumb and fore-finger, explaining that the ear was the coolest part of the body.

The celebrated Dr. Fresenius, of Wiesbaden, having appropriated some discovery or method of Bunsen, without giving credit, was cordially disliked by him, and he once showed it by a significant act. A student accosted the Hofrath as he passed by and put to him some simple question in analytical chemistry; on the desk lay open a copy of Fresenius's '*Anleitung*,' whereupon Bunsen closed the book with a deprecatory gesture, pulled out the drawer of the student's desk to its extreme limit, and thrust into it as far back as possible the objectionable volume, saying: "*Nun, mein Herr*, we will proceed."

Bunsen was rather sensitive to criticism; one of my American colleagues tells me of an incident illustrating this. The professor proposed to the student the joint preparation of certain Cesium and Rubidium salts, saying he would secure several barrels of the mineral water rich in the chlorides and would have the water boiled down to a small volume ready for the separation of the rare elements. The American felt highly pleased at the flattering proposal and to show his interest in the matter mentioned that he had studied under Professor O. D. Allen, of New Haven, who had done work on Cesium and Rubidium. This was an unfortunate remark, however, for Allen had corrected Bunsen's figures for the Atomic Weight of Cs., and the Hofrath remembering this never again mentioned the subject to my friend.

In those days students were obliged to prepare some substances now commonly provided, and to construct some apparatus with their own hands. Every student had to etch and calibrate his own eudiometer, and some of them wasted much time over the hydrofluoric acid process before getting good results. I remember, too, purifying potassium hydroxid by solution in alcohol (an extra charge), and evaporation in a large silver basin loaned by an assistant. One green, Russian student bought at Desaga's potassium cyanid instead of the hydroxid and was vainly trying to dissolve it, walking about the laboratory shaking the bottle for hours, when Bunsen noted its singular appearance, he caused the operation to be suspended, and on ascertaining the nature of the substance cautioned the student against it.

Speaking of Russians reminds me of an amusing occurrence; one of them was instructed to precipitate a substance '*mit überschüssigem Kali*,' and not finding any bottle labelled '*überschüssiges Kali*,' he inquired for it of a neighbor, who mischievously sent him to Dr. Bender, telling him the article was kept under lock and key with other costly substances, such as silver nitrate and platinum chlorid. The astonished assistant explained to the Russian that an *excess* of potash did not require a special bottle; the student was nicknamed '*Überschüssiges Kali*' for the rest of the *semester*.

Many nationalities were represented in Heidelberg laboratory, besides Russians there were Bessarabians, Hollanders, Bohemians, Germans from North and from South, Austrians, one Chilian, one Englishman (the late Dr. Walter Flight), one Scotchman, one Irishman and several Americans, fifty-nine students in all, of which fifty-eight were incessantly smoking; the fumes of tobacco mingled with vapors of H_2S, SO_2, HNO_3, and NH_3, making an atmosphere so thick that I regret not having cut off a slice as a souvenir.

The students, from time immemorial, had

a voluntary organization to maintain order in the laboratory; they elected at the beginning of each *semester* an officer known as '*Polizei-Diener*,' who was authorized to impose small fines for petty offenses, the money thus secured being devoted at the end of the term to the purchase of books for the small library placed on shelves in the balance-room. This custom I understand still obtains. At the opening of my third term I was elected '*Polizei*,' and duly instructed in my duties; being watchful and courageous I collected more money during my term of office than had been added to the library fund for many years. The misdemeanors for which fines were imposed were leaving an unused gasburner lighted, failure to resort to the '*Stink-Zimmer*' when noxious gases were generated, failure to replace bottles or apparatus used in common, and leaving a balance door open or weights on the pans, which latter was accounted a very heinous offense; the fines ranged from six kreutzers (Baden) to half a gulden. My official life was marked by two events that greatly excited and amused the whole laboratory; one of the events was regarded as an exhibition of unparalleled audacity, of which only an American was capable—I fined Hofrath Bunsen! The Professor, after lighting his cigar at the flame of a Bunsen burner left the gas burning and went out of the room; according to custom, and to the consternation of the students, I chalked on the desk that Bunsen had used, the words '6 Kr.' over my initials, a notice that could not be erased until the fine was paid. Next day when Bunsen approached the desk, he glanced at the inscription, smiled broadly, and to the amusement of the crowd of students that had gathered to see the result of my daring, opened his purse and handed me the six kreutzers with a pleasant commendation of the fidelity of the '*Polizei*.'

The other event concerned a very close-fisted American whose numerous fines I was unable to collect; when they reached the enormous sum of one and a half gulden, (about 60 cents), I consulted some of the older German students stating the facts and asking for advice. They declared they had never heard of such a case, and they authorized me to confiscate some chemical apparatus belonging to the American and to sell it at auction. I secured a fine beaker-glass, the outside one of a large nest, and after due notice, amid the shouts of the 59 students gathered in the lecture-room the beaker was sold at auction; the competition to secure it was so keen that it brought a very high price, the sum covering the fine plus the value of the glass. The excess had to be paid back to the lucky American, so that the fine did not come out of his pockets, after all.

Several times in the course of his life Bunsen was injured by explosions; he was popularly believed to be minus one eye, one ear, and one lung, and there is some foundation for this, for he lost an eye when working at cacodyle, and he was slightly deaf. It was related of him that on one occasion a violent explosion threw him to the ground and made him unconscious, on coming to, his first words were: "Has any of the substance been saved?"

In 1865 Bunsen was invited to fill a chair in the University of Berlin, and after due consideration he declined the flattering call to the delight of all educational Heidelberg. In his honor the students organized a torch-light parade; the chemists marched in a body, and carried away by enthusiasm I imprudently joined them, carrying a torch with the crowd. The procession paraded the principal streets and then assembled in the open square before the *Aula*, or central Hall of the University; there the students singing the Studenten Lieder and formed a ring, gradually closed in towards the center, mak-

ing the ring smaller, until at a given signal they threw their half-burned torches into the very center and the pile blazed on high, making an impressive ceremonial. I have said I imprudently joined because I failed to anticipate the disagreeable consequences; the smoke of a half-a-thousand torches, the dripping grease, and the dust of the streets, combined with the moist exudation of my membranous integument, to form a black deposit that would have honored a stoker, besides ruining a suit of clothes.

During my residence in Heidelberg a lamentable and terrible affair took place that threw a profound gloom over the University and the entire town. Two German students having quarreled decided the earth was not large enough for both of them to live in, and resorted to the diabolical practice called the 'American Duel.' In a darkened room the two young men drew lots, having sworn that he who drew the black ball would commit suicide. The unhappy loser went to his room and discharged a bullet into his breast, but missed his heart and lingered for several days on his deathbed; his parents were summoned by telegraph and besought him on their knees to disclose the name of his antagonist, but he steadfastly refused and died with the secret in his breast. The students not only excused his conduct but praised his courage, and when his remains were taken to the railway station to be transported to a distant city, they accompanied the funeral cortége with torches and music. The students claimed he was not a suicide for he was killed in an honorable duel, and they maintained that his opponent was not accessory to his death because he shot himself; I had many arguments with them and never could convince them of their extraordinary tergiversation.

The whole system of dueling at Heidelberg is an interesting feature of student life that I had good opportunities of observing without taking part, but, as Kipling says, 'that is another story.'

The intimacy of Bunsen and Kopp is well known, I have often seen them walk through the narrow streets hand-in-hand like affectionate schoolgirls, Bunsen's large frame and Kopp's diminutive stature making a strong contrast.

Bunsen had great talents and personal attractions yet he did not succeed in fostering original work on the part of those who studied with him; I think this is partly due to the fact that they were chiefly beginners and when they had acquired the rudiments of general chemistry they took to the fertile fields of organic chemistry under other masters. Yet his pupils include some men of high rank in the profession, Lothar Meyer, Sir Henry Roscoe, Beilstein, Lieben and Carius.

I last saw Geheimerath Bunsen during a brief visit to Heidelberg in 1891; he had retired from active duty and complained of the infirmities of advancing years, being subject to rheumatism, but he exhibited the same cordial manner, the charming smile, and a willingness to listen to the accounts of Americans who had pursued their studies in the Heidelberg Laboratory. Bunsen died after a lingering illness, August 16, 1899, at the great age of 88.

Among the Americans contemporary with me may be named:

Eli W. Blake, afterwards professor of physics at Brown University, deceased.

Orren W. Root, afterwards professor of chemistry at Hamilton College, deceased.

Charles Wolf, of Cincinnati, deceased.

George M. Miller, of New York.

Harry McBurney, of Boston.

Lyman Nichols, of Boston.

Arnold Hague, of the United States Geological Survey.

Frank Slingluff, of Baltimore.

There was no club or association among the Americans such as exists in Göttingen,

and a full list of Americans who studied under Bunsen could only be made from the official register of the university.

Of the charm of residence in the picturesque little city on the Neckar, with its magnificent ruined castle, its attractive forest-covered hills threaded by enticing paths, its historical associations, and its excellent beer, there can be but one opinion; but in winter we often felt the truth of the old couplet:

> 'Heidelberg ist eine schöne Stadt
> Wenn es ausgeregnet hat!'

Henry Carrington Bolton.

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*A SKELETON OF DIPLODOCUS, RECENTLY MOUNTED IN THE AMERICAN MUSEUM.**

In the spring of 1897, one division of the American Museum exploring party was sent by the writer to the Como Bluffs of Wyoming, made famous by numerous discoveries of Dinosaurs. It was believed that this rich locality had been exhausted by the continuous excavations of the United States Geological Survey under the direction of Professor Marsh. The first prospecting, however, resulted in the discovery, by Mr. Barnum Brown and the writer, of a large femur, which guided us to a very remarkable skeleton of *Diplodocus longus* Marsh. Dr. J. L. Wortman joined the party later and superintended the work of excavation which occupied several months.

At one time strong hopes were aroused that the entire animal would be found together. The long tail stretched off parallel with the cliff, interrupted only by a narrow gully which

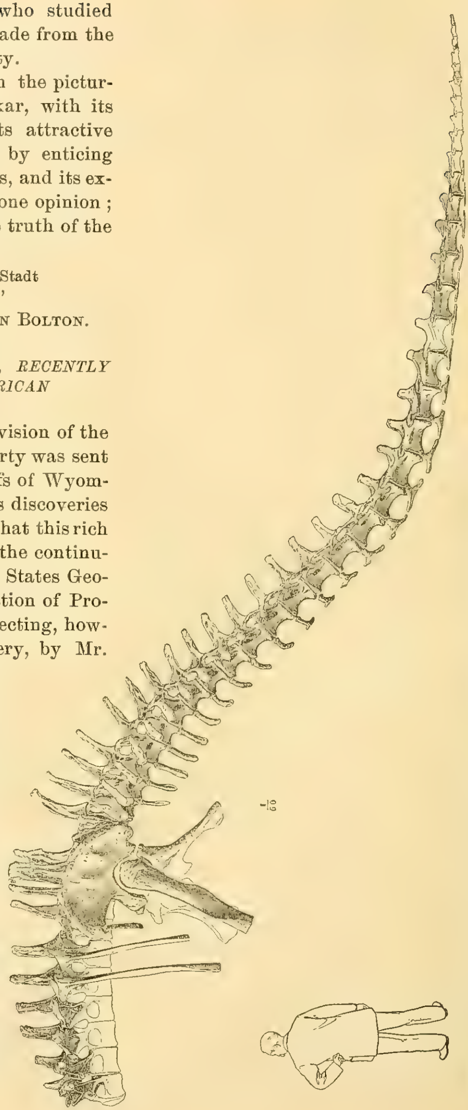

Fig. 1. Posterior half of Vertebral Column of the Diplodocus Skeleton with Pelvis and Femur in Position. Parts missing in contours. The figure is of a man of the average height. $\frac{1}{50}$ nat. size.

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had cut through a small section of the caudals. In front of the sacrum the dorsals stretched forward in a promising way, but the centra were wanting, and finally nothing but the neural arches remained. The left side was found most deeply imbedded and most completely preserved in the region of the sacrum. The bones recovered, with the exception of three cervical vertebræ and the complete right scapula, are shown in the accompanying restoration. Not only the relative completeness of this skeleton, but the highly skillful manner in which it was taken out, render it unique. Upon arrival in the Museum, the reconstruction of the pelvis and sacrum proved especially difficult, but was completed successfully.

The points of greatest novelty are found in the vertebral column, since the only portions of this region described by the late Professor O. C. Marsh are a single cervical, an anterior dorsal, three sacral centra, and one caudal with chevrons. In order to understand the general structure of the posterior half of the column, that is from the 8th presacral backwards, the reader is referred to the restoration, Fig. 1. A remarkable *balance between the opisthocœlous presacrals and procœlous postsacrals* is observed. Vertebra for vertebra they correspond very nearly in size, with a slight advantage in favor of the presacrals. The balance was completed by the ponderous tail stretching out to a length of 30 feet. Between these balanced dorsals and caudals are the excessively rigid sacrals, coalesced with each other and with the ilium. Thus a long balanced vertebral lever is established with the acetabulum as a fulcrum, with opisthocœlous vertebræ in front and procœlous vertebræ behind. The dominating principle in construction of the backbone is maximum strength with minimum weight. The ingenuity of sculpture by which this is brought about, every single vertebra differing from its fellow, baffles the Lamarckian as well as the Darwinian, and tempts us to revive the old teleological explanation. The neural spines, arches and centra are constructed in such a manner as to connect all the principal points of stress and strain, and at the same time reduce the weight to the last degree. They are proportioned in each vertebra to meet its peculiar conditions, no two vertebræ being alike.

Presacrals 2 and 1 are of great interest because, as in the Struthious birds, the ribs they bear lie behind the ilium, the 14th being still free, the 15th having coalesced with the ilium. The analogy with *Apteryx* is very striking.

The *three anterior sacrals*, constituting the primitive Dinosaur sacrum, are firmly united together by their neural spines. These spines coalesce into a single very robust spine, showing the diapophysial laminæ separate; the antero-posterior diameter of this spine is far less than that of the three coalesced spines of *Brontosaurus* or *Morosaurus*.

The sacrum of Sauropoda is reinforced by the addition not of dorsals, but of anterior caudals. The third sacral was probably the first of the anterior caudals to be added in an ancestral stage of evolution. The fourth sacral is still more conspicuously a modified caudal.

This is the first instance among the Sauropoda in which a nearly complete sacrum has been found attached to the ilium. This fortunate circumstance determines *the correct position of the ilium with relation to the sacrum*, and shows that the entire pelvic girdle has been incorrectly placed hitherto; Marsh's error consisted in his placing the anterior and posterior acetabular borders, or pubic and ischiac peduncles, of the ilium upon the same horizontal plane, thus directing the superior iliac crest backwards; and altering the natural angle of the entire pelvis. The second point of great interest

is the marked elevation of the sacral spines above the ilium and the uniquely extensive and powerful union betwen the sacrum and ilia. The sacral spines are not only the highest spines in the vertebral column, but, as in the birds, the sacro-iliac junction is the center of power and of motion, and is of the most rigid character.

The completeness of the tail with its chevrons is of great moment; 37 caudals is the number estimated; 29 is the number fully or partly preserved; 26 chevrons are preserved. The length of the tail is estimated at 9 meters, or about 29 feet—this estimate is obtained by the addition of the actual lengths of the centra.

The caudals thus steadily increase in length from the first to the 18th and then steadily diminish toward the extremity. Totally dissimilar from the caudals of other reptiles, and even from those of other Dinosaurs, the caudals of Sauropoda or Cetiosauria are distinguished by profound changes in different regions. In proportions the anterior caudals are *short*, relatively *broad*, and spreading with heavy rugosities, as the seat of the powerful musculature of the tail, sacrum and femur. The median caudals (of the type first described by Marsh) are *long*, *narrow* and contracted, as the seat of the propelling fin; the posterior caudals are long, slender cylinders. There are no less than five types of chevrons.

The *ilium* is finely preserved; the superior crest is perfect, but the anterior border is flattened or crushed inwards instead of turning sharply out to allow space for the two posterior ribs which lie in behind it. The superior crest, is directed mainly upwards, the rugose border of the crest is surmounted by five diapophysial rugosities, that is those springing from the first presacral vertebra, and from the four sacrals. The function of the heavy pre-acetabular bar appears to have been to support the weight of the body when the anterior portion of the trunk was raised and the tail depressed.

Of the shoulder girdle only the *scapula* is preserved. Singularly enough this is the right scapula, for most of the skeleton represents the left side. The *femur* is a highly characteristic bone. It is distinguished by a prominent trochanter placed on the posterior border, near the middle of the shaft, which apparently corresponds with the *fourth trochanter*, tr^4, of Dollo. This is for the insertion of the great *femoro-caudal* muscles of birds and Dinosaurs. This femur is much more slender than that of *Brontosaurus* and has rather the proportions of the *Amphicœlias altus* femur described by Cope.

The greatly extended and revised knowledge afforded by this specimen may now be summarized.

Dorsals.—The neural spines arise from the convergence of paired cervical spines. There are no nodal or broad-spined dorsals as in *Brontosaurus*. The rib articulations are greatly elevated in the posterior dorsals. The two posterior dorsals are placed behind the ilium and bear one free and one coalesced or vestigial rib. *Sacrals.*—There are four sacrals, three of which exhibit a complete coalescence of the spines, the fourth being more free and like a caudal. The sacro-iliac union is by means of sacral ribs and diapophysial plates. Additions to the sacrum are made from the caudal series. *Caudals.*—All the anterior caudals have broad diapophysial laminæ. These plates were first observed by the writer in *Brontosaurus* or *Camarasaurus*. There are five distinct types of chevrons. One of these, belonging to the 18th or 19th caudal, is the type to which Marsh assigned the name *Diplodocus*. *Ilium.*—The superior crest of the ilium is directed upwards, and the coalesced sacrals form the center of motion and the highest portion of the vertebral

column. There is a balance of weight between the dorsals and the anterior caudals. The laminar construction of the dorsals, sacrals, and caudals is shown to exhibit a unity of type, with local differences adjusted to special stresses and strains.

RESTORATION AND HABITS OF DIPLODOCUS.

We must await the discovery of the complete limbs and neck before *Diplodocus* can be wholly restored. Yet a number of important points regarding the general structure of the animal can be established now. The length of the entire skeleton was considerably greater than estimated by Marsh. The known and estimated linear measurements are as follows :

	Feet.	Meters.
Caudals	30	
Sacrals	2	.60+
Dorsals (estimated)	12	3.65
Servicals (estimated)	12	3.65
Skull	2	61
Total	58	8.51

The animal was about 60 feet in length and relatively more elevated and more slender than *Brontosaurus*. The proportions of the shafts of the femora, namely *Diplodocus* 5, *Brontosaurus* 7, probably give us an approximate idea of the weight ratio—that is, *Diplodocus* had about five-sevenths the bulk of *Brontosaurus*.

We observe in Marsh's restoration of *Brontosaurus*, a pioneer work of very great difficulty, that the mid-dorsal region is made the highest point in the backbone; that the sacral region is subordinate; that the tail (in which 8 or 10 anterior caudals are now know to be omitted) is an *appendage* of the body instead of an important locomotor organ of the body. In all these points Marsh's restoration is probably incorrect.

We must consider therefore as three of the most important advances in our general knowledge of the structure of these animals; first, the establishment of the sacral spines as the highest point in the backbone; second, of the sacrum and ilium as a center of power and motion; third, of the balance between the dorsals and caudals.

Diplodocus gives us a new and different conception of the Cetiosaurs or Sauropoda, one which increases their ability as aquatic reptiles, and specializes the functions of the tail. The tail constitutes one-half the length of the animal, and was of immense service as a propeller in enabling it to swim rapidly through the water, the broad anterior portion being provided with very powerful lateral muscles, and the compressed posterior portion being controlled by tendons and made effective by a vertical fin.

The tail, secondly, functioned as a lever to balance the weight of the dorsals, anterior limbs, neck and head, and to raise the entire forward portion of the body upwards. This power was certainly exerted while the animal was in the water, and possibly also while upon land. Thus the quadrupedal Dinosaurs occasionally assumed the position characteristic of the bipedal Dinosaurs—namely, a tripodal position, the body supported upon the hind feet and the tail.

Thirdly, the *supporting function* of the posterior half of the tail is indicated by the sudden change in the shape of the chevrons at the 13th caudal; the chevrons of caudals 13 to 19 indicate the region to which part of the main weight of the body was transmitted; these chevrons are powerful and broadly spread out at the bottom. The 18th chevron is firmly anchylosed with the centrum; the 19th, 20th, 21st, 23d, 24th, 25th, are firmly connected with the centra by sutural surfaces, though not anchylosed.

What may be termed the 'supporting and balancing' tail of the Hadrosaurs, Iguanodonts and Megalosaurs is of a much simpler type than this 'balancing, supporting and propelling' tail of the Cetiosaurs.

There is a traditional view that these animals were ponderous and sluggish. This view may apply in a measure to *Brontosaurus.* In the case of *Diplodocus* it is certainly unsupported by facts.

As compared with the Crocodilian or Cetacean type, the axial skeleton of *Diplodocus* is a marvel of construction. It is a mechanical triumph of great size, lightness and strength. Judging by the excessive rugosity of the vertebræ and limbs, the powerful interspinous ligaments attached to the pre- and post-spinal laminæ, the backwardly directed rugosities at the summits of the diapophysial laminæ in the dorsals, and of the postzygapophysial laminæ in the caudals, the animal was capable not only of powerful but of very rapid movements. In contrast with *Brontosaurus* it was essentially long and light-limbed and agile. Its tail was a means of defense upon land and a means of rapid escape by water from its numerous carnivorous foes. Its food probably consisted of some very large and nutritious species of water-plant. The anterior claws may have been used in uprooting such plants, while the delicate anterior teeth were employed for prehensile purposes only. The plants may have been drawn down the throat in large quantities without mastication, since there were no grinding teeth whatever. It is only by some such means as this that these enormous animals could have obtained sufficient food to support their great bulk.

Henry Fairfield Osborn.

THE NOMENCLATURE OF THE NEW YORK SERIES OF GEOLOGICAL FORMATIONS.

The prime outcome of the work of the four geologists, Mather, Emmons, Vanuxem, Hall, engaged upon the original survey of the State of New York, was the promulgation of a series of terms designating and classifying the rock formations. Many of the terms adopted in the final reports issued in 1842–1843 had been previously introduced in the annual reports of one and another of the geologists, but that finally announced was the mutual agreement of the four. Tradition and contemporary record have given us some evidence that differences of opinion as to the merits of various terms erected during the progress of the survey were not wholly reconciled by the final pronouncement which rejected a goodly number of provisional names. It was clearly the purpose of the geologists to institute and defend a classification of the older rocks, the stratigraphic units of which were to be of approximately equal value. In several instances subdivision of such units was recognized; thus Hall and Vanuxem especially added the term *group* to some units as indicative of a minor subdivision of the strata. Emmons avoided this term wholly and Mather seldom employed it.

The geologists also made use of a broader assemblage of the units into associations termed by some of them *groups,* by others *divisions.* These were four in number, namely, beginning at the bottom : Champlain, Ontario, Helderberg, Erie, and a fifth, Catskill, was employed by Mather. There was pretty uniform agreement in the use of these broader terms and such slight discrepancy as became apparent in their application was no more than an expression of imperfect knowledge and of personal equation. It was a genuine misfortune to the New York nomenclature that disturbed and drove out these terms which are supremely adapted to the unequaled paleozoic succession from which they emanated. In many respects they meet the actual conditions far more satisfactorily than the European terms which we are now carrying. They are entitled to respect for their venerableness and, where consistent with the present state of knowledge, to recognition for their merit.

It will be observed that the classification proposed by the four geologists was wholly

stratigraphic. It did not purpose to express the time units or groups thereof except so far as such a subdivision of the strata must of itself imply a corresponding division of time. Nor did the geologists contemplate any uniform grouping of their units in terms intermediate between their major and minor divisions.

It has, however, come to pass that such a grouping of the early New York units has found its way into quite general use. Such terms as Niagara group, Hamilton group, Chemung group, are current expressions in contemporaneous writings and they are not employed at all in the sense in which they were sometimes used by Vanuxem and Hall. This fact is well known and it is generally recognized by all students concerned with the stratigraphy of the early formations, that this condition has come about indirectly through the influence of the important summaries of American geology published by the late Professor J. D. Dana (Manual of Geology, four editions). In presenting the succession of paleozoic events these works have treated the subject as history must be treated, as a succession of time units. These units, which have been termed epochs, were grouped together into periods, and each period was given the name of the most conspicuous, widely distributed or otherwise best characterized of its epochs. Thus have arisen terms for secondary divisions in the paleozoic history of New York which duplicate names that must remain permanently in use for time units and their stratigraphic equivalents. The duplicating terms thus introduced into New York history are the following: Trenton, Niagara, Onondaga, Corniferous, Hamilton, Chemung. The distinguished author to whom reference has been made never employed these terms in any other than a chronologic sense; the present frequent application of them with a stratigraphic meaning of precisely the same scope as the time divisions, is a perfectly natural and legitimate outcome. This practice has, however, not only caused confusion from duplication within the boundaries of the State, but it has led to much embarrassment in the correlation of the stratigraphic succession of other states with that of New York. The point has doubtless been reached when these terms, representing though they do important divisions of time and sedimentation, must give way to others of equivalent value which shall obviate the duplication and confusion with which we are now embarrassed.

This paper, frankly stated, is a proposition to substitute for these terms in their stratigraphic application and hence necessarily in their chronologic equivalence, a series of designations derived from characteristic localities of the New York paleozoic, and thus to preserve, under the necessity of change, the eminent title of New York State to its full and ancient representation in the classification of the paleozoic deposits and time.

Incidentally it also takes cognizance of and suggests a suitable remedy for the present incongruity in the nomenclature of the stratigraphic units. As the propriety and necessity of local terms for the designation of such units is generally acknowledged, those formations which have hitherto borne names of other significance are now superseded by appropriate geographic names.

1. Champlainic. This most appropriate designation was introduced by the concurrence of the four geologists for the formations here assigned to it (exclusive of the Potsdam sandstone), and it has clear right of way over the later application of the name to the period of post-glacial alluvium. That the later term has become ingrained in literature renders it all the more conspicuous as an infraction of the law and of the rights of the men who first proposed it. In the face of Champlain, 1842, the term Ordovician has no standing.

2. Ontaric. Vanuxem placed the base of the Ontario division at the 'gray sandstone,' Hall and Emmons at the Medina, Mather at the Shawangunk

THE NEW YORK SERIES.

Era or System.		Period or Group.	Age or Stage.
Cambric or Taconic		Georgian	Georgia slates
		Acadian	
		Potsdamian	Potsdam sandstone and limestone
Champlainic (1) (Lower Silurian and Ordovician)		Canadian (3) (Paleochamplainic)	Beekmantown limestone (15)
			Chazy limestone
		Mohawkian (4) (Mesochamplainic)	Lowville limestone (16)
			Black river limestone
			Trenton limestone
		Cincinnatian (5) (Neochamplainic)	Utica shale
			Lorraine beds (17)
			Richmond beds (Ohio and Indiana)
Ontaric (2) or Siluric		Oswegan (6) (Paleontaric)	Oneida conglomerate
			Shawangunk grit
			Medina sandstone
		Niagaran (7) (Mesontaric)	Clinton beds
			Rochester shale
			Lockport limestone
			Guelph dolomite
		Cayugan (8) (Neontaric)	Salina beds
			Rondout waterlime (18)
			Manlius limestone (19)
Devonic	Paleodevonic	Helderbergian (9)	Coeymans limestone (20)
			New Scotland beds (21)
			Becraft limestone (22)
			Kingston beds (23)
		Oriskanian (10)	Oriskany beds
	Mesodevonic	Ulsterian (11)	Esopus grit (24)
			Schoharie grit
			Onondaga limestone
		Erian (12)	Marcellus shale
			Hamilton beds
	Neodevonic	Senecan (13)	Tully limestone
			Genesee shale
			Portage beds (Naples beds, Ithaca beds, Oneonta beds, local facies)
		Chautauquan (14)	Chemung beds (Catskill sandstone, (25) local facies)

grit. Vanuxem and Hall terminated the division above with the Niagara, Emmons included the Salina and waterlime. Any rational grouping of these formations must recognize as its base the predominance of coarse sedimentation installing a new cycle. Growing evidence fully endorses Emmons' view as to the termination of the group and period with the clearing of the Salina sea.

3. Canadian. This term has the prestige of time and priority.

4. Mohawkian. Conrad and Vanuxem made use of the term 'Mohawk limestone' for certain of the calcareous layers beneath the Trenton, but they differed so widely in their application of the term that in the summation of their results, the geologists decided to abandon it. The name is here revived with a broader meaning. The valley and watersheds of the Mohawk river afford typical exposures of all members of the group.

5. Cincinnatian. The formations of the Neo-champlainic are not as completely developed in the State of New York as in Ohio and Indiana. In the latter sections the Lorraine fauna is represented, but is followed above by the well-defined fauna of the Richmond beds. Probably in no other region is the succession of these faunas so complete as about Cincinnati, and this fact justifies the recognition of the term Cincinnatian, which already has historic value. For a full description of the series by Winchell and Ulrich, see Geol. and Nat. Hist. Surv. of Minn., vol. 3, pt. 2, pp. ci–cv., 1897.

6. Oswegan. This name is appropriate on account of the widespread occurrence of the Oneida and Medina formations in Oswego County, N. Y. Vanuxem employed the term 'Oswego sandstone' for the formation subsequently and by common consent called Medina sandstone. In reviving the name, though with a broader meaning than in its original use, it derives its title from its early date.

7. Niagaran. In the sense suggested by Professor Dana.

8. Cayugan (new). The divisions of this group are knit together by lithologic and faunal characters and are distinctly Ontaric. The outcrops are typically exposed about the north end of Cayuga Lake, N. Y.

9. Helderbergian. The present state of our knowledge does not permit the use of the term Helderberg in its original scope. The 'Helderberg division' was made to embrace formations now regarded as constituting the lower and part of the middle Devonic. We propose to restrict the term Helderbergian to the formations currently known as 'Lower Helderberg,' excluding the 'Tentaculite limestone.'

10. Oriskanian. The Oriskany formation varies considerably in the character of its sediment. Its calcareous facies is highly developed in eastern New York, while the more siliceous sediment excludes all others in the central part of the state. The fauna of the Oriskany from its lowest beds, as at Camden, Tennessee, to its highest beds, as in the Province of Ontario, shows progress in differentiation, but it is not yet practicable to subdivide the New York development of the fauna.

11. Ulsterian (new). From the outcrops of all the members in Ulster county, N. Y.

12. Erian. The 'Erie division' comprised the formations from the top of the Onondaga limestone to the top of the Chemung. We propose to save the term to the New York nomenclature by reviving it with a restricted meaning.

13. Senecan (new). In Seneca county and along the shores of Seneca lake are excellent exposures of these beds.

14. Chautauquan (new). From exposures in Chautauqua county, N. Y.

15. Beekmantown limestone (new). The Calciferous sandrock of Eaton and authors generally. This formation took its original name from sections in the Mohawk valley, where the rocks are without fossils. At Beekmantown, N. Y., the normal fauna is finely developed and the rock section essentially complete.

16. Lowville limestone (new); instead of Birdseye limestone of common use. Lowville is a town in Lewis county, N. Y., where these beds are well exposed.

17. Hudson river beds. It is becoming increasingly evident that the great mass of shale in the Mohawk and Hudson river valleys which was designated at an early date by this term is resolvable into horizons extending from the middle Trenton to and including the Lorraine beds. At present it seems unlikely that when this determination of horizons has been carried through the series any part will remain to which the original term can be applied by virtue of its distinctive fauna, though it may still serve to designate a facies of the formations mentioned.

18. Rondout waterlime (new). From the fine development of these beds in the extensive cement quarries at and near Rondout, N. Y.

19. Manlius limestone. Tentaculite limestone of Gebhard, Mather and later writers. The name here used was introduced by Vanuxem and is entitled to first consideration. Manlius is the place of typical exposure in Onondaga county, N. Y.

20. Coeymans limestone (new); and

21. New Scotland limestone (new). These terms designate respectively the Lower Pentamerus (Helderberg and Pentamerus limestones of the New York geologists) and the Catskill or Delthyris shaly limestone. Coeymans and New Scotland are adjacent towns in Albany county, N. Y., through which runs the Helderberg escarpment affording the finest exposures of these formations.

22. Becraft limestone. This name was introduced by N. H. Darton with the sanction of Professor James Hall, for the beds previously known as the Upper

Pentamerus and Scutella limestones of the Helderberg sections. The present name is derived from Becraft mountain, Columbia county, N. Y.

23. Kingston beds (new). The 'upper shaly beds' of W. M. Davis, which are typically exposed and attain a thickness of 250 feet in the vicinity of Kingston, N. Y.

24. Esopus grit. Proposed by Darton, with the approval of Professor Hall, for the old term Caudagalli grit. It has been suggested by Frech that the Esopus grit should be regarded as a part of the arenaceous sediments of the Oriskany. The very few fossils which it contains, however, do not as yet fully endorse this suggestion.

25. Catskill sandstone. This is an approximate expression of the value of this formation. Catskill sedimentation doubtless began as early as Portage time, its representation during which is expressed in the term, Oneonta beds.

John M. Clarke,
Charles Schuchert.

FISH FAUNA OF THE WOODS HOLE REGION.

In the issue of Science for October 21st, 1898, the writer noticed the capture in the vicinity of Woods Hole, Mass., within a few years, of 12 species of fishes new to the fauna of southern New England, including 5 not previously known from United States waters. These additions raised the number of species recorded from the Woods Hole region to 222, including 11 strictly fresh-water forms.

The summer and fall of 1899 yielded an extraordinary number of unlooked-for species. Although the season was in some respects unfavorable, owing partly to the almost total absence from the inshore waters of the floating sargasso-weed under which the tropical forms drift in from the Gulf Stream, and although a number of the regular visitants were tardy in arriving and appeared in only limited numbers, the season as a whole was unprecedented for the number of new and rare fishes taken. Most of the species to be mentioned were observed only in Katama Bay, a small body of shallow water separating the eastern end of Martha's Vineyard from Chappaquiddick Island. On August 30th, when this bay was first visited by a party from the Fish Commission laboratory, 4 species not previously known from the region were noted, in addition to a number of rare southern forms. Between that date and October 17th, the bay was industriously seined, at short intervals of time, along about one mile of the eastern shore, and the subtropical fishes were invariably found. On September 1st no less than 9 other species new to the locality were detected, and 4 others were obtained on September 16th, 19th, and 29th. By November 18th, when the last visit was made, the water temperature had fallen to 47° and no rare kinds were caught.

At times the number of species represented in a single seine-haul in Katama Bay was unprecedented for the Woods Hole section, and surpassed by but few Florida or West Indian records. Thus, on September 1st, the record for the day was 56 species, of which 47 were taken at one set, including 7 species not reported from points north of Florida until this year.

The species hereafter mentioned bring the list of Woods Hole fishes to 240. This is a larger number than has been recorded from any other locality in the United States with the exception of Key West, in which region upwards of 250 species have been noted.

RARE SPECIES OBSERVED IN 1899.

Exocœtus heterurus Rafinesque. Flying-fish. Very rare; in 1886 and possibly on one previous occasion this fish has been detected at Woods Hole. A specimen 12 inches long was seined at Menemsha Bight, Martha's Vineyard, on August 1st, 1899; at the same place another, somewhat smaller, was caught in a fish trap on August 21st.

Rachycentron canadum (Linnæus). Cobia; Crab-eater. Rarely observed in recent years and none for a number of seasons; commoner 25 years ago than at any time since; only small (5 or 6 pound) specimens

heretofore observed. On July 18th, 1899, a fine example $4\frac{3}{4}$ feet long and weighing 60 pounds was caught in the Fish Commission trap in Buzzard Bay, and retained alive until August 31st.

Tetragonurus cuvieri Risso. SQUARE TAIL; SEA-RAVEN. This very rare species, described from Nice in 1810, was until 1890 known only from the coast of southern France and the Madeira Islands. The original describer considered it a deep-water form that approached the coasts only for spawning purposes. On November 10th, 1890, the species was added to the western Atlantic fauna by the capture of a specimen at Woods Hole. The taking of another specimen at the same place, on August 1st, 1899, now recorded for the first time, is most interesting and unexpected; the fish, about $1\frac{1}{2}$ inches, was found under a mass of floating rock-weed in Vineyard Sound.

Epinephelus niveatus (Cuvier & Valenciennes). SNOWY GROUPER. Straggling specimens of this tropical species have occasionally been taken in Rhode Island and Massachusetts waters, the first Woods Hole examples being obtained in 1895. In Katama Bay, the fish was common from the latter part of August to the first part of October, 1899, and was observed on every day the bay was visited; upwards of 75 were secured during the season.

Pseudopriacanthus altus (Gill). BIG-EYE. A rare straggler from the West Indies; described by Dr. Gill from Narragansett Bay; recorded from Woods Hole and several other points on Massachusetts coast. In summer and fall of 1899, the fish was common in Katama Bay, almost every seine-haul yielding specimens; over 100 were taken before the advent of cold weather.

Lutianus analis (Cuvier & Valenciennes). MUTTON-FISH. Normal range from Florida to Brazil; north of Florida known only from Woods Hole, in 1876 (7 specimens) and 1897 (2 specimens). In Katana Bay during September, 1899, the fish was found on six different days, and upwards of 20 small specimens were taken.

Chætodon ocellatus Bloch. BUTTERFLY-FISH. A few specimens of this tropical species have been obtained at Woods Hole nearly every year in October and November, 5 being the largest number in one season. In 1899, the fish was positively common at times, and more were collected in Katama Bay than have probably ever been observed in any other locality. Throughout September and until the third week in October, the gaudy little fish were constantly found in the shore waters; 80 were obtained on September 1st, and 50 more on each of three other days, the aggregate number observed during a period of seven weeks being over 400. Some of these were so small as to suggest that they must have hatched after reaching Massachusetts waters.

Chætodon bricei Smith. BUTTERFLY-FISH. Prior to 1899, only 6 specimens of this species, all taken at Woods Hole in 1897, were known. In September, 1899, at Katama Bay, it was found on seven different days, in company with *Chætodon ocellatus*, and over 40 specimens were obtained. During the recent Porto Rican expedition of the Fish Commission, a specimen was secured at Fajardo.

Alutera monoceros (Osbeck). FILE-FISH. The detection of this very interesting East Indian species on our coast at Woods Hole in August, 1898, was referred to in SCIENCE for October 21st, 1898, and is the subject of a recently issued paper by the writer.* While possibly this is the species recorded from Cuba by Parra in 1787 and by Poey in 1863, the evidence is far from conclusive. The seining of a second specimen, $8\frac{1}{2}$ inches long, at Menemsha Bight, on August 1st, 1899, is now recorded.

* Notice of a file-fish new to the fauna of the United States. Bulletin United States Fish Commission 1898. Pp. 6 and colored plate.

of

Spheroides spengleri (Bloch). Swell-fish; Swell-toad. The normal habitat of this species is Florida and Texas to Brazil; the only northern locality from which it is recorded is Woods Hole, where it was observed only in September and October, 1877. During September, 1899, the fish was common in Katama Bay, more individuals being observed on some days than of the common swell-fish (*Spheroides maculatus*).

RECENT ADDITIONS TO THE FAUNA.

Murœna retifera Goode & Bean. Moray. Described from the coast of South Carolina in deep water, and heretofore known only from that locality. A very large specimen was taken in a lobster pot near Tuckernuck Island on July 25th, 1899; it was 6 feet 2 inches in length, 18 inches in circumference, and weighed 39 pounds. This huge eel was subsequently exhibited in New Bedford as a 'sea serpent.' It was identified by Dr. H. C. Bumpus.

Holocentrus, sp. Squirrel-fish. A young squirrel-fish, differing from the common Florida and West Indian species, *H. adscensionis*, and apparently representing one of Poey's imperfectly described Cuban species, was taken in Katama Bay on September 1st. There is no other record of the occurrence of a squirrel-fish north of Florida.

Apogon maculatus (Poey). King-of-the-Mullets. This species has been recorded from Florida, the West Indies, and Brazil; it is not rare on the snapper banks off the west Florida coast, and has frequently been found in the stomachs of snappers and groupers. There is no record of its occurrence anywhere on our coast north of Key West, although a related species, *Apogon imberbis* (Linnæus), was once reported from Newport, R. I., by Cope. On September 1st, 1899, 6 specimens were taken at one seine-haul in Katama Bay, and on September 16th, 5 more were caught at one set at the same place.

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Epinephelus morio (Cuvier & Valenciennes). Red Grouper. This well-known Florida and West Indian food fish is known from Virginia, and was also recorded from New York by the describers and by DeKay, although no one since the latter's time has reported it so far north and he himself relied on the testimony of fishermen. The detection of the fish in the vicinity of Woods Hole in 1899 is now announced, 5 specimens being taken in Katama Bay on September 1st, and 2 on September 16th; these were all young, from 3 to 4 inches in length.

Epinephelus adscensionis (Osbeck). Rock Hind. Previously known range, Florida Keys to Brazil, Ascension Island, and St. Helena Island. One small example was taken by the Fish Commission in Katama Bay on September 19th, 1899.

Garrupa nigrita (Holbrook). Black Jewfish. A number of small specimens, found during September in company with *Epinephelus niveatus* and bearing a remarkable superficial resemblance to that species, are with some hesitation identified as the black jewfish, the young of which is undescribed. The species ranges from South Carolina to Brazil.

Mycteroperca bonaci (Poey). Marbled Rockfish; Black Grouper. This fish is known from the west coast of Florida and about Key West, whence its range extends through the West Indies to Brazil. One specimen, 5 inches long, was seined in Katama Bay on September 19th, 1899.

Mycteroperca, sp. Ten specimens of a small grouper were obtained in Katama Bay in September and October. They are apparently referable to *M. interstitialis* (Poey), known only from Cuba, but may be the young of some other species. Only one member of this genus has heretofore been detected on our coast north of Florida.

Eupomacentrus leucostictus (Müller & Troschel). Cocky-pilot. The hitherto known range of this species, which was described

from the Barbadoes in 1848 in Schomburgk's history of that island, was the West Indies to Key West and the west coast of Florida. Between August 30th and October 4th, 1899, nine small specimens of uniform size were taken on five different days in Katama Bay.

Teuthis hepatus Linnæus. SURGEON-FISH; TANG; LANCET-FISH.

Teuthis cœruleus (Bloch & Schneider). BLUE SURGEON; BLUE TANG.

Teuthis bahianus (Castlenau). BARBEIRO. These three species are recorded from Florida, the West Indies, and Brazil; the first-named has been taken as far north as Charleston, S. C. During August, September and October, 1899, all of them were found in some numbers in Katama Bay, and about 50 specimens were obtained on seven different occasions. The last examples were secured on October 4th, when the three species were represented in one seine-haul. About half the specimens are referable to the common species (*T. hepatus*). All the examples are small, although those last taken exhibit a slight increase in size compared with those caught early in September.

Lactophrys triqueter (Linnæus). TRUNK-FISH. This fish inhabits the West Indies, Florida, and the Bermudas, but has not been previously reported from Massachusetts, although the common trunk-fish, *Lactophrys trigonus* (Linnæus), has been known from the region for many years and is taken at Woods Hole every season. A number of small specimens of *L. triqueter* were obtained in 1899; several collected in 1897 and earlier years had been identified as *L. trigonus*.

Lactophrys tricornis (Linnæus). TRUNK-FISH; COW-FISH. This widely distributed species has been reported as far north on our coast as Chesapeake Bay, whence its range extends to the Gulf of Mexico, West Indies, Brazil and west Africa. Its occurrence in the Woods Hole region, in company with the following species, was noted for the first time in September, 1899, when it was found on 4 or 5 occasions in Katama Bay. All of the specimens were small. On November 6th, 1899, a fish 15½ inches long was washed ashore at Cuttyhunk.

Chilomycterus antillarum Jordan & Rutter. BUR-FISH. Described from Jamaica in 1897; in 1868 cited from Cuba by Poey as '*C. fuliginosus* or a doubtful species;' and not heretofore known from any other localities. On September 7th, 1897, a small specimen was taken in Quisset Harbor, near Woods Hole.

Scorpæna plumieri Bloch. SCORPION-FISH. This species, which is common from the Florida Keys to Brazil, has not been recorded north of Key West. On seven days in August, September, and October, 1899, the fish was found at Woods Hole, and 20 small specimens were taken.

Scorpæna grandicornis Cuvier & Valenciennes. SCORPION-FISH; LION-FISH. The normal range of this species is southern Florida to South America, in shallow water. One small example was secured in Katama Bay on September 29th.

HUGH M. SMITH.
U. S. COMMISSION OF FISH AND FISHERIES.

ZOOLOGY AT THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

COLUMBUS MEETING, A. A. A. S.

THE work of this Section showed a flattering increase of interest over recent years and a list of papers of more than usual value. The discussions were often animated and general, and the effect of the meeting as a whole was to give a very encouraging future for the Section. The address of the Vice-President, Professor S. H. Gage, of Ithaca, N. Y., was a very practical paper and the views expressed received very general concurrence. It has already been published in the columns of

this JOURNAL on pages 305–315, September 8, 1899.

The following is a complete list of the papers read, accompanied by short abstracts:

The Utility of Phosphorescence of Deep Sea Animals. C. C. NUTTING, Iowa City, Iowa.

The paper is an attempt to explain phosphorescence in terms of utility to its possessors. When possessed by free swimming forms it acts in a manner analogous to 'alluring coloration,' in some cases. In others it reveals the prey, in others it may be 'directive,' and in still others protective in function. Among the Protozoa it may serve to keep individuals of a species together, and thus secure conjugation. When possessed by fixed forms, such as many coelenterates, the phosphorescence does not serve the purpose of warning coloration, nor is it useful to attract the mate, or sex elements of opposite sexes, but it is useful in attracting many organisms that serve as food for its possessors.

Investigation of the Course of the Fibers in the Optic Chiasma of Bufo lentiginosus. BURTON D. MYERS, Ithaca, N. Y.

1. The decussation is total. 2. The chiasma is made up of a crossing of fibers and not of bundles of fibers as described by the earlier writers. 3. There is not that gradually increasing complexity of decussation in the chiasma from fishes to mammals as described by Wiedersheim. 4. There are no interretinal fibers. 5. The trophic center for at least the greater part of the fibers of the optic nerve is in the retina. 6. On experimental grounds the toad is capable of monocular vision. 7. After loss of sight of one eye, contrary to the old belief, the toad does not die of starvation. 8. Flemming's fluid hardening is superior to Marchi's method in that the normal nerve tracts are absolutely free from those blackened granules so closely resembling degeneration. 9. Degeneration after severance of the optic nerve of the toad is first seen after five days.

On Reighardia, A New Genus of Linguatulida. HENRY S. WARD, Lincoln, Nebr.

In the air sacs of gulls on Lake St. Clair was discovered in 1894 a vermiform parasite which could not be definitely placed. It occurred infrequently and even when found was present in small numbers. The host was *Bonaparte's Gull.* Last year the same parasite was found in the common tern on Lake Erie. Here it is even rarer, only one bird in 100 being infested. One of the three parasites obtained was a female containing well developed embryos and, from their character, it was easy to determine the taxonomic position of the parasite as closely related to the Linguatula. Subsequent careful study showed also the characteristic hooks of the family, yet very poorly developed. The body is elongated, cylindrical transparent and devoid of any annulations. The cuticula is thin, bearing around the mouth-opening a chitinous framework recalling that of the Sarcoptidæ. Of its post-embryonic development nothing is known. Our species of Linguatula is recorded from a gull of Arctic Ocean. This form, which is incompletely described, probably belongs to this new genus, a view strengthened by some minor details mentioned by the author.

Photographing Natural History Specimens under Water or other Liquids with a Vertical Camera. SIMON H. GAGE, Ithaca, N. Y.

The purpose of this paper was to show by specimen photographs what could be done in getting accurate pictures of live aquatic animals and of delicate specimens which must be supported in liquids. By means of a vertical camera, this is as easily accomplished as photographing in the ordinary horizontal position. The most notable

photograph, perhaps, was that of a live fish with five just transformed lake lampreys attached.

On some Heteropterous Insects formerly Responsible for Spider-bite Stories. L. O. HOWARD, Washington, D. C.

This paper was published in full in *Appleton's Popular Science Monthly* for November, 1899, pp. 31–42, under the title 'Spider Bites and Kissing Bugs.'

Cave Animals, their Character, Origin and their Evidence for or against the Transmission of Acquired Characters. CARL H. EIGENMANN, Bloomington, Indiana.

Cave faunas bear the same relation to those of the neighboring regions that island faunas bear to those of neighboring continents, but caves are not as a rule colonized by accident. As far as the vertebrate fauna is concerned only those types are represented which in their epigean existence were negatively heliotropic, and caught their food under rocks, under logs and in crevices, the amblyopsid salamanders, rats, etc. A gradually disappearing light leads to an increase in the size of the eyes, viz.: nocturnal animals in general; whereas the gradual diminution of the use of the eyes leads to the reduction of their size and the simplification of their histological complexity whether light is present or not.

The degeneration, if it takes place in the light, affects first the retina, then the dioptric arrangement, and finally the purely passive structures, as the scleral cartilages. The lens, after it is once affected, degenerates much more rapidly than the other elements, and usually disappears before the other structures vanish. The evidence from the differential degeneration is for the transmission of disuse effects. The habits and structure of the species of blind fishes and the differential degeneration mentioned eliminate the possible influence of natural selection, panmixia compensation of growth principle, or germinal selection, as factors in the phylogenic degeneration of these eyes.

Have we More than a Single Species of Blissus in North America? F. M. WEBSTER, Wooster, Ohio. Published in the Amer. Nat., Oct., 1899, pp. 813–817.

Æstivation of Epiphragmophora Traskii in Southern California. MRS. M. BURTON WILLIAMSON, Los Angeles, California.

This paper, read by title, described an experiment with two *Epiphragmophora traskii* to ascertain how these snails suspended in the air would remain with the functions of digestion and respiration in a state of torpor, and also to compare their longevity with other helices of the same colony kept in a snailery in the garden.

Natural Taxonomy of the Class Aves. R. W. SHUFELDT, Takoma, D. C.

This paper, read by title only, briefly takes into consideration the origin of birds as a group, as evidenced by the structural organization of its living members, and a study of such fossil material as has fallen into the hands of science. An historical sketch is presented giving the main features of the various schemes of classification of the Class, in times past, by the best recognized authorities, with critical comments thereon. The peculiar difficulties attending the classification of birds is contrasted with the problem as presented by other groups of the vertebrata. Such morphological characters as best subserve the purposes of avian taxonomy are examined into and compared, with brief notes upon their significance and value. A scheme of classification of the Class Aves is presented wherein osteology has been the main anatomical system used, although by no means to the exclusion of the remainder of the bird's structure.

Notes on the Chick's Brain. SUSANNA PHELPS GAGE, Ithaca, N. Y.

A systematic review of the development

of the brain of the chick has been undertaken with the end in view of determining the real value of the furrows upon the mesal or endymal surface of the brain tube. In the earliest stages, while the dorsal union is taking place, there is a furrow demarkating the region adjacent to the neural crest from the remainder of the nervous tube and ending in the optic cup. As the neural crest separates into ganglia which grow down the side of the tube this furrow disappears and the brain tube assumes the well-known moniliform with total folds of the wall.

Of the five transverse furrows of the oblongata, two certainly leave a remnant which can be traced definitely to the 9th and 10th days. To that time there is not reëstablished a continuous longitudinal furrow throughout the brain tube separating the so-called dorsal and ventral zones of His, but in each portion of the brain arise furrows of limited extent which from comparison with other brains promise to prove of value in homologizing parts.

Further Notes on the Brook Lamprey. (*Lampetra wilderi.*) Simon H. Gage, Ithaca, N. Y.

In this paper were brought out the additional facts bearing upon the non-parasitic habits of the adult brook lamprey.

1. It was shown that the lake lamprey, as soon as completely transformed, attacked fish with great ferocity.

2. Transformed brook lampreys under the same conditions never attacked the fish.

3. The alimentary canal of the lake lamprey was comparatively large with many secondary, longitudinal folds at the time of transformation, while that of the brook lamprey was very small and quite or almost completely unfolded.

Bearing upon the question of possible ancestral parasitism in the brook lamprey, serial sections were made of the larvæ at the beginning of transformation, when the transformation was nearly complete and of the adult at the spawning season. It was found:

1. That the branchial apparatus undergoes the same modification as in the lake lamprey in that the common branchial chamber becomes divided into seven branchial pouches on each side, and the formation of a common median branchial canal opening into the mouth and by passages into each branchial pouch.

2. That there is developed an esophagus connecting the mouth with the alimentary canal as in the known parasitic forms (lake and sea lamprey).

4. The buccal and lingual armature of horny teeth is well developed.

It was concluded that the indications all point to an almost certain conclusion that the progenitors of the brook lamprey were true parasites although at present the brook lamprey possesses the esophagus which is not used for swallowing food and buccal and lingual teeth which are no longer used for lacerating prey, but remain as stigmata of an ancestral mode of life.

Respiration in Tadpoles of the Toad. S. H. Gage, Ithaca, N. Y.

On comparing the behavior of toad tadpoles with that of the tadpole of the bullfrog, for example, one is surprised to find that the toad tadpoles go to the surface with far less frequency, and if the water is very fresh they may appear not to go to the surface at all. In a small glass vial they may remain at the bottom for half an hour or more. An investigation of the development of the lungs showed that they appear very early, that is long before the hind legs, but it was found that the opening of the trachea into the mouth through the glottis, and the development of the larynx did not occur until the tail was nearly absorbed. From this structural condition there could

be no aërial respiration by the lungs in the tadpole state as the lungs do not communicate with the exterior, but are closed sacs.

The apparent aërial respiration of the toad tadpole is explicable only on the ground that air is taken in and mixed with the water which passes over the internal gills, something as fish go to the surface and gulp air when air dissolved in the water is too nearly exhausted.

Effects of Hydrocyanic Acid Gas upon Animal Life and its Economic Use. W. G. JOHNSON, College Park, Md.

A preliminary report upon a series of experiments with this gas upon animal life.

A Discussion of Aspidiotus cydoniæ and Its Allies. C. L. MARLATT, Washington, D. C.

This paper was published in full in the *Canadian Entomologist* for August, 1899, pp. 208–211, under the title '*Aspidiotus convexus*—a correction.'

The Histogenesis of Muscle in the Metamorphosis of the Toad (Bufo lentiginosus americanus). B. F. KINGSBURY, Ithaca, N. Y.

The author spoke of the occurrence of metamorphosis in the development of certain animals, among them the toad, the necessity of changes in metamorphosis, histolysis and histogenesis of the tissues, etc.; the views on the changes constituting histogenesis of tissues, muscle especially; the results of work on the toad and frog; and the bearing of these results on general biological principles.

The Progenitors of the Batrachians. THEO. GILL, Washington, D. C.

This paper gave evidence showing that the Batrachians are probably descended from a type of fishes most nearly represented in the present fauna by the Polypterids.

Observations on the Variations, Life History and Habits of a Mimetic Locust (Œdipoda maritima Uhl). HERBERT OSBORN, Columbus, Ohio.

Discussion of the possible factors affecting variations in a locust which shows striking protective resemblance and some observations regarding habits and life history.

A Chart Illustrating the Origin and Evolution of Animal and Vegetable Life. A. D. HOPKINS, Morgantown, W. Va.

An original scheme for illustrating theories on the origin and evolution of forms, genera, families, orders, etc., of life by means of a disk divided into spaces of various sizes and forms and by curved and straight lines rising from the center of the disk.

Geographical Variations, as Illustrated by the Horned Larks of North America. HARRY C. OBERHOLSER, Washington, D. C.

Discusses the distribution of the Horned Larks; their relation to faunal areas; their distribution compared with other plastic groups; geographical variation in the Horned Larks, and comparison of variation in other groups; anomalies in variation of the Horned Larks; an examination into the causes of geographical variation.

C. L. MARLATT,
Secretary.

SCIENTIFIC BOOKS.

REPORT OF THE FUR SEAL INVESTIGATIONS, 1896–1897.

The Fur Seals and Fur Seal Islands of the North Pacific Ocean. By David Starr Jordan, President of Leland Stanford, Jr., University, Commissioner in Charge of Fur Seal Investigations of 1896–1897; with the following Official Associates: Leonhard Stejneger and Frederic A. Lucas, of the U. S. National Museum; Jefferson Moser, Lieutenant-Commander, U. S. N., in command of the U. S. Fish Commission Steamer *Albatross;* Charles H. Townsend, of the U. S. Fish Commission; George A. Clark, Secretary and Stenographer; Joseph Murry, Special Agent; with

Special Papers by other Contributors. Part 1 [–4]. Washington: Government Printing Office. 1898 [=1899]. 4 vols. 4to. Part 1, pp. 1–249, i.–vii., pll. ia.–ic., iia.–iic., iii.–ix., frontispiece, and 25 unnumbered plates. Part 2, pp. 251–606. Part 3, pp. i.–xii., 1–629, pll. i.–xcv., frontispiece, 6 maps, and a large number of text cuts. Part 4, pp. 1–384, pll. 1–113 (pll. 87–113=maps and charts).= Treasury Department Document No. 2017.

[Although dated '1898,' parts 1, 2 and 4 were issued in July, 1899, and Part 3, not till November, 1899.]

This apparently exhaustive report, consisting of 1637 pages, and 250 plates, charts and maps, is perhaps the most important contribution yet made to the voluminous literature of the vexed question of the Fur Seal industry of the North Pacific, contributed by officials of the United States. The occasion of the present inquiry is thus set forth: "The present inquiry into the condition and needs of the fur seal herds of the North Pacific Ocean and Bering Sea is the outgrowth of a belief on the part of the United States that the regulations formulated by the Paris Tribunal of Arbitration for 'the protection and preservation of the fur seal' had failed to accomplish their avowed object. The inadequacy of these regulations was apparent at the close of the first season of their operation, and each succeeding season has only rendered it more conspicuous. Failing to secure the coöperation of Great Britain in the immediate revision of the regulations, the United States, in the spring of 1896, accepted the proposal of Great Britain for a scientific investigation of the whole subject, to be made independently by each nation, the result of such investigation to form the basis of a reconsideration of the regulations at the end of the special trial period of five years."

Pursuant to an act of Congress, Dr. David Starr Jordan was appointed commissioner in charge of the investigation, with, as associates, Lieutenant-Commander Jefferson F. Moser, commanding the U. S. Fish Commission steamer *Albatross;* Dr. Leonard Stejneger, curator of reptiles, U. S. National Museum; Mr. Frederic A. Lucas, curator of comparative anatomy, U. S. National Museum, and Mr. Charles H. Townsend, naturalist of the *Albatross.* Great Britain appointed as her commission, Professor D'Arcy Wentworth Thompson, of University College, Dundee, Scotland; Mr. Gerald E. H. Barrett-Hamilton, of Dublin, Ireland, and Mr. James Melville Macoun, of the Geological Survey of Canada; while the Canadian government detailed Mr. Andrew Halkett to investigate the operations of the pelagic fleet. The *Albatross*, with the American Commisson and Prof. Thompson and Mr. Macoun of the British Commission reached St. George Island, July 8, 1896, and the members of the two commissions conducted their investigations, usually in company, till late in October. The following year work was begun early in June, and continued till the end of the season, the two commissions working in company at the Pribilof Islands, while Dr. Stejneger made a very thorough survey of the Asiatic fur seal islands and fur seal industry.

Part 1 contains the principal findings of the commission; part 2 consists of supplementary documents, giving in full the basis of these conclusions; part 3 comprises some thirty separate papers by nearly as many different authors, chiefly on the natural history of the fur seal, and on the fauna and flora of the Pribilof Islands; while part 4 is Dr. Stejneger's report on the Russian fur seal islands. Part 1, after stating the occasion and scope of the inquiry, gives a historical summary of the American fur seal industry, followed by an account of the home of the Pribilof Island seal herd, including the geography, climatic conditions, the natural productions, etc., of the islands, and the number, location and character of the seal herds. Chapter IV. discusses the fur seal or sea bear in its zoological relationships, the conclusion being reached that the three herds of northern fur seals—the Pribilof herd, the Komandorski herd, and the Robben Island herd—not only do not mingle, but constitute three distinct species, which are termed, respectively, *Callorhinus alascanus*, *C. ursinus*, and *C. curilensis.* The various categories of seals, as regards sex and age, their migrations and life habits are next detailed, followed by a history of the past and present conditions of the Pribilof herd. The decline in the herd is carefully traced and

its cause convincingly set forth, which is primarily, if not exclusively, *pelagic sealing.* The history and effects of pelagic sealing are presented in detail, and the facts speak for themselves; there is no occasion for argument. Statistics show that in the average about 75 per cent. of the seals taken in pelagic sealing are *breeding females*, killed either on the way to their breeding grounds while pregnant, or on their feeding grounds near the rookeries, leaving their nursing pups to die of starvation on the rookeries. In the case of land killing, only certain classes of males are taken, leaving the full quota of females to replenish the herd.

While pelagic sealing is so destructive to the seal herd, statistics show that it is not remunerative, but, on the contrary, is carried on at a pecuniary loss to those engaged in it. "The true nature of the business was plain in 1897, when only 38 vessels, as against 87 in 1896, engaged in sealing." Of this latter number 21 were American and 66 British (*i. e.*, Canadian). The amount of capital invested for this year (1897) did not exceed $208,000, to be "contrasted with the capital of $5,000,000 invested in the preparation of the seal skins in London, and with the revenue of $1,375,000 a year which the United States should by right be enjoying." Pelagic sealing is, therefore, a selfish, dog-in-the-manger business. As said in President Jordan's report (p. 175): "Not only is pelagic sealing a destructive and wasteful industry, but it is suicidal in its nature. It is at best but an insignificant industry. It threatens the destruction of vastly more important interests, and with them its own interests. Pelagic sealing preys upon its own capital. The more successful it is the quicker will come its ruin. Its bankrupt condition to-day is clearly shown in the declining catch and the withdrawal of its vessels." This was perfectly evident to well-informed and unbiased experts in 1893, yet the evidence before the Arbitration Commission was so confused and so vitiated by false statements and false inferences that the rules established by the Paris award for the preservation of the seal herd only fostered its rapid destruction through its provisions in behalf of pelagic sealing!

In this connection it seems proper to quote a few paragraphs from the report (pp. 175, 176), since they tersely summarize the subject of pelagic sealing and place the odium of its continuance in the right quarter.

"Such is the nature of pelagic sealing, the sole cause of the threatened destruction of the fur seal herd, the sole obstacle which stands in the way of its restoration.

"Much has been said of the legality of pelagic sealing, and to this we take no exception. Pelagic sealing is perfectly legal, but this legality was fixed by a tribunal which was so confused by false testimony and ignorant and worthless affidavits, that, while attempting to formulate measures for the protection of the seals, it legalized the very cause of their destruction. But the whitewash of respectability which was thus put upon pelagic sealing cannot hide its true character. Judged by its methods and results, it is merely a species of legalized barbarism. Pelagic sealing is simply a public nuisance which can now only be disposed of by international agreement.

"It is a great sense of relief that we find ourselves able to record the recent action of Congress in the prohibition of the practice of pelagic sealing by our own citizens, and the exclusion of skins of females from our markets. This step should have been taken long ago. It must be remembered that until the passage of this law Americans as well as Canadians have been engaged in slaughtering the fur seals. * * * And not only have our citizens helped to destroy our own herd, but they have crossed the Pacific and have been instrumental in depleting the herd of friendly Russia. American enterprise has also had the leading part in the practical extermination of the fur seal rookeries of the Kuril Islands, belonging to Japan.

"Henceforth, however, our hands are clean, and we can with dignity and assurance urge that other nations take steps to put an end to the business. Pelagic sealing—with its slaughter of gravid females, and the starvation of their dependent young, with its waste of a noble and valuable animal life, with its threatened destruction of varied and important commercial enterprises, and of the sole source of supply of a commodity of utility and value to mankind—is, from this time on, distinctly a Canadian indus-

try, and under the fostering care of Great Britain. If she permits its continuance, the odium must rest with her."

The remedy proposed by the American Commission for the present decline of the herd is 'the absolute and permanent prohibition of pelagic sealing.' The herd is at present commercially ruined, but it is believed that with judicious management it can be brought up, in the course of fifteen to twenty years, to its former maximum condition.

The recommendations formulated by the commission not only include the complete cessation of pelagic sealing, but recommend that the herd should be "placed permanently in charge of a competent naturalist and practical man of affairs, whose business it shall be to visit the islands each year in the breeding season and to study the condition of the herd and ways for its improvement; to determine the size of the quota which shall be taken, and supervise its taking; in short, to make the needs, possibilities and limitations of the fur seal herd his life study. By such a course the government can hope to have at hand at all times that expert advice and assistance that have been so signally lacking in the past, and which is so essential to the proper administration of its future interests."

Following these recommendations in Part 1 are several appendices, giving statistics pertinent to the preceding discussion, relating to the number of seals killed on the Pribilof Islands and in pelagic sealing, from about 1870 to 1897; also the treaties and other documents between Great Britain and the United States on the fur seal question. Noteworthy among the latter is the joint statement of the fur seal experts of the two governments, drawn up and signed in Washington, at the conclusion of the field work of the two commissions, in November, 1897. The agreement of the two commissions, thus shown upon all matters touching the decline and present condition of the seal herd, and the causes that have led to its present unsatisfactory status, is certainly most gratifying, and augers well for its future.

The numerous illustrations in Part 1 are mainly reproductions of photographs, and illustrate various phases of the subject under discussion. There are, however, a dozen drawings from nature by Bristow Adams, depicting characteristic types of seal life. A series of photographs illustrate seal life as seen massed on the rookeries; while another set show the methods of driving, killing and skinning; still another set (numbered as plates i.–ix.) illustrate the decline of the herd, the views being comparative views of the same rookeries taken in different years from 1894 to 1897.

Part 2 of the report, forming pages 251–606, is largely a transcript of the daily observations of the commission during the two seasons of its work at the Pribilof Islands, and gives in detail the evidence on which the conclusions of the commission, set forth in Part 1, were based.

Part 3 contains twenty-four distinct chapter headings, fourteen of which relate directly or indirectly to the natural history of the fur seal, occupying pp. 1–339, and the remainder to the general natural history of the Pribilof Islands, the volume, as a whole, forming a most important contribution to the zoology and botany of this now pretty thoroughly known group of islands. These contributions may be briefly summarized as follows: 'I.—The Pribilof Fur Seal' (pp. 1–7), treats of the 'main divisions of the Pinnipedia,' and 'variations in size and color of the Pribilof seal,' by Mr. F. A. Lucas, while Dr. Jordan and G. A. Clark consider 'the species of the *Callorhinus* or northern fur seal,' of which three are recognized, namely, (1) *C. ursinus* (Linn.), constituting the Commander Island herd; (2) *C. alascanus* Jordan & Clark, the Pribilof fur seal; (3) *C. curilensis* Jordan & Clark, the Robben Island fur seal. These species differ appreciably, not only in size, and in the texture, color and commercial value of the fur, but occupy distinct geographical ranges, and do not commingle, even in their migrations.

Under 'II.—The Anatomy of the Fur Seal' (pp. 9–41, pll. i.–viii.), Mr. Lucas describes the dentition of the fur seal, Robert E. Snodgrass, its anatomy, and Pierre A. Fish, the brain of the fur seal, in comparison with that of other Pinnipeds and the black bear.

'III.—The Breeding Habits of the Pribilof Fur Seal' (pp. 43–57, pll. ix.–xi.), is by Mr. Lucas, as is also 'IV.—The Food of the North-

ern Fur Seal' (pp. 59–68, pll. xii.–xv.); 'V.—Mental Traits of the Pribilof Fur Seal' (pp. 69–74), and 'VI.—The Causes of Mortality among Seals' (pp. 75–98, pll. xvi.–xxi.). Chapter 'VII.—Internal Parasites of the Fur Seal' (pp. 99–177, and 100 text illustrations) is an elaborate report by Ch. Wardell Stiles and Albert Hassall, which incidentally includes a notice of the intestinal parasites of other marine mammals.

'VIII.—The early history of the Northern Fur Seals' (pp. 179–222), is a translation of George William Steller's 'De Bestiis marinis' (1751), by Walter N. Miller and Jennie Emerson Miller, and of Veniaminof's account of the sea bear (1839), translated by Leonhard Stejneger —both pertinent to the general subject, and here made accessible to English readers.

'XI.—Pelagic Sealing, with Notes on the Fur Seals of Guadalupe, the Galapagos, and Lobos Islands' (pp. 223–274, pll. xxii.–xxxv., and 2 maps), by Charles H. Townsend, is historical and statistical, and a most valuable and comprehensive contribution.

'X.—Report of an Expedition in Search of the Fur Seal of Guadalupe Island, Lower California, June, 1897; including a survey of the Island, and notes on the Animal and Plant Life of the Region' (pp. 275–283), and 'XI.—Observations during a Cruise of the *Dora Siewerd*, August–September, 1895' (pp. 285–306), are by A. B. Alexander. 'XII.—Fur Seal Hunting in the Southern Hemisphere' (pp. 307–319), by J. A. Allen, is reprinted from the proceedings of the Fur Seal Arbitration (App. to U. S. Case, Vol. I.].

'XIII.—The Rookery Maps of the Pribilof Islands' (pp. 321–324), is a brief report by Jefferson F. Moser, on the past unsatisfactory attempts to construct such maps, with comment on the difficulties of the work.

'XIV.—Practical Experiments in the Branding and Herding of the Seals' (pp. 525–538, pll. xxxvi. and xxxvii.), is by David Starr Jordan and George A. Clark, who claim that, in a method of rendering the skins unsalable, they give the keynote to the whole situation, and, carried to logical conclusions, would 'forever settle the vexed question of pelagic sealing.'

'XV.—The Blue Fox of the Pribilof Islands' (pp. 339–343), by D. S. Jordan and G. A. Clark, treats of the blue fox as one of the important resources of the islands, from the great commercial value of its fur, and recommends the protection of the herd from undue inroads.

'XVI.—Mammals of the Pribilof Islands' (pp. 345–354), by Frederick W. True, is an annotated list of 12 species. One of these is the introduced house mouse, 4 are seals, and 4 are cetaceans, the only indigenous land animals being a shrew, a lemming, and the Arctic fox. The sea otter and walrus, formerly present, have been exterminated.

'XVII.—The Avifauna of the Pribilof Islands,' by William Palmer (pp. 355–431, pll. xxxviii.–xli.). This paper of nearly 80 pages consists of a carefully annotated list of the 69 species of birds thus far known from the islands, with an analysis of their distribution and a discussion of their migrations. The annotations are often extended and relate not only to the nesting and other habits, but to changes and conditions of plumage, etc. Pll. xxxix. shows variation in the markings of the eggs of the Pacific murre, and pll. xl. and xli. the development of feathers.

'XVIII.—The Fishes of Bering Sea' (pp. 433–492, pl. xlii.–lxxxv.), is by David Starr Jordan and Charles Henry Gilbert; 229 species are enumerated and several are described as new, while many others are for the first time figured. This general title covers also a paper by Norman Bishop Scofield, entitled, 'A List of Fishes obtained in the Waters of Arctic Alaska' (pp. 493–509), enumerating 33 species.

'XIX.—A Contribution to the Knowledge of the Tunicata of the Pribilof Islands' (pp. 511–537, pll. lxxxvi., and 28 text figures). Of the 11 species here described and illustrated 10 are new.

'XX.—The Mollusk Fauna of the Pribilof Islands,' by William H. Dall (pp. 539–546, with a map). This consists of several pages on the general character and relations of the fauna, followed by tabular summaries for (1) the Pribilof Islands (86 species); (2) the Commander Islands (74 species), and (3) fossil species, from both groups of islands.

'XXI.—List of Insects hitherto known from the Pribilof Islands' (pp. 547–554), compiled by E. A. Schwarz.

'XXII.—List of Crustacea known to occur on and near the Pribilof Islands' (pp. 555–557), by Mary J. Rathbun.

'XXIII.—A List of the Plants of Pribilof Islands, Bering Sea, with Notes on their Distribution' (pp. 559–587, pll. lxxxvii.–xciv.), by James M. Macoun.

'XXIV.—Algæ of the Pribilof Islands' (pp. 589–596, pl. xcv.), by William A. Setchell, Ph.D. An index of 32 pages concludes the volume.

Part 4, relating to (A), 'The Asiatic Fur Seal Islands and Fur Seal Industry,' and (B) 'The Kuril Fur Seal Islands and the Fur Seal Industry of Japan,' is by Dr. Stejneger. The first, he tells us, is based on "observations gathered during four different visits to the Commander Islands, off the coast of Kamchatka, the first undertaken in 1882–83, in the palmiest days of the fur seal industry; the second during 1895, as a special attaché of the United States Fish Commission, to study the recent decline and to compare the conditions as I knew them thirteen years ago, with those of the present day. My third trip took place in 1896, by direction of the President, pursuant to the joint resolution of Congress approved June 18, 1896, and the fourth one in 1897, under the same auspices." It is thus obvious that the investigation of the Russian Fur Seal Islands was placed in exceptionally competent hands, and the results of Dr. Stejneger's investigations of fur seal life in Russian waters has not only a most important bearing on the general subject of the fur seal industry in northern waters, but also upon that of the Pribilof Islands. The decline in the fur seal herds at the Commander and Robben Islands has been as marked in recent years as has that of the Pribilof herd, due, beyond question, to the same cause—pelagic sealing. Dr. Stejneger gives first an account of the topography and climate of the Commander Islands, with a sketch of its fauna and flora, and the native inhabitants, and an account of the number, location and extent of the seal rookeries on both the Commander and the Robben Islands. Then follows 'Seal Life on Commander Islands' (pp. 82–113); 'The Russian Sealing Industry' (pp. 114–216); 'A Comparative Study of the Conditions of the Sealing Industry on the Pribilof and Commander Islands' (pp. 217–228), with 'Conclusions' and 'Bibliography' (pp. 229–236). As Dr. Stejneger was also familiar with the fur seal life of the Pribilof group, he was especially fitted for the comparative study of the conditions found in the Russian waters.

The Kuril Islands are treated upon the same general plan as the Commander Islands; and although the Doctor's stay was here comparatively brief, it was practically a virgin field for such an investigation, his report giving us almost the first available information concerning not only the seal life but the general natural history of this group of barren, little known islands.

These four volumes of the 'Report of Fur Seal Investigations' are thus by no means confined to the fur seals themselves, or to questions in dispute as to the cause and extent of the decline of the herds and their proper future management, but is broadened to include the history and natural history of the Pribilof and other islands involved in the inquiry, as incidental and pertinent to the general subject. There hence results as the work of the Commission, first, a most thorough and judicial report on the 'fur seal question,' in its broadest sense, and secondly and incidentally, a most welcome contribution to the zoology and botany of the islands in Bering Sea and adjacent waters, all highly creditable to the Commission and its coworkers.

J. A. Allen.

A Theory of Reality. By George T. Ladd. An Essay in Metaphysical System upon the Basis of Human Cognitive Experience. New York, Charles Scribner's Sons. 1899. 8vo. 556 pages.

The present volume is the culmination of the author's studies and discussions of certain problems, already defined and treated from other points of view in his Elements of Physiological Psychology, published in 1887, Psychology, Descriptive and Explanatory, of 1894; Philosophy of Mind, 1895; and Philosophy of Knowledge, 1897. The central thought in this whole philosophy appears to be the adoption of Self as the model and measure of reality. This

is expressed in the following passages: "For in our view, the one fundamental reality, the actual Being whose characteristics are recognized by the categories, whose work is both nature considered as the system of material things and also all the spirits of men considered in their historical development, is the Absolute Self. And the innermost essence of such an Absolute Self is Spirit. From Spirit, then, come nature and all spirits; and in dependence on this Spirit they live and develop. And the proof of this view lies in the fact that to rely on nature as a unifying principle it is necessary to include in our conception of nature the characteristics of a spiritual life." (Pp. 458 and 459.) Again, "The different spheres of reality as known by man are distinguished by the amounts of essential selfhood which they possess." (P. 401.) Again, "for every knower there are only two possible kinds of objects, which can claim for their reality the immediacy of an incontestable knowledge; these are the Self, and Things. As the knowledge of the self changes and develops the more external and less central factors of this object—the members of the body as viewed from the outside and even the brain as imagined or thought—become, for the Self, other things than itself. Always the primary evidence for the existence and the activity of all other selves is the knowledge of things; for each Self, every other being—other men included—is known as 'a Thing.'" (Pp. 348 and 349.) "Psychologically considered, then, all actual measurement of real quantities consists in the self-appreciation of the varying amounts of the own-life of the Self." (P. 301.) These quotations will indicate the author's metaphysical point of view.

Readers of SCIENCE will be more interested in the attempts of the author to define the various forms in which the mind conceives real things, which are the subject matters of science. It is the founding of a metaphysical theory of reality upon knowledge of particular, concrete things that distinguishes this treatise from what may be called purely metaphysical books. The author states that, "Whatever the human mind may know, or conjecture, about the Unity of Reality, about the One, the Absolute, the World-Ground—or any other term philosophers have chosen for this unitary conception—man's first-hand, verifiable, and common knowledge is the knowledge of particular existence. For every human mind knowledge is, and remains, knowledge of the self and of other concrete beings—their qualities, relations, and transactions. From this knowledge of particulars all theory of reality must set out; to this knowledge all theory must be ready to return, for its correction and its testing, again and yet again." (P. 133.)

The scope of the book, as a theory of reality, is concisely described by the author at the close of Chapter IV., as follows: "The detailed exposition of such a theory * * * involves the discussion and illustration of the following fundamental truths. Each of them is a truth which has its roots in the primitive facts and in the maturer growths of knowledge, but which is also ontological in its nature and application. First: All the categories are forms, both of knowledge and of being, that are actually and indubitably realized in all our cognitive experience with the Self. I am a Being whose existence and whose self-knowledge is constituted a Unity, because I am a self-conscious Self. Second: All the real beings which are known as Things, together with their attributes, changes, relations, laws, etc., are made actual in our cognitive experience only as there is projected into them, so to speak, the same forms of Being which I know the Self to have. The categories, so far as they can get any recognizable meaning in their application to actual things, are the same categories as those under which we know the Being of the Self. Third: The Unity in a world of reality which all things and all minds have is known in terms of an all-inclusive and Absolute Self. Only the conception of 'Selfhood' can bring into actual and cognizable Unity that complex of concrete realities which both the work-a-day and the scientific experience of the race contains. And this unifying conception is properly held by the mind, not as a mere conception, but as the ultimate form given by reflective thinking to our knowledge of Reality." (Pp. 109 and 110.)

The discussion of the conceptions of 'force and causation,' 'forms and laws,' 'matter,' and the distinction between 'nature and spirit,' are

full of suggestive thoughts for physicists, chemists and biologists, who are too apt to overlook the many metaphysical conceptions used by them in their most rigid scientific investigations.

On the other hand, the scientist or the 'plain man,' accustomed to use trans-subjective things as his models of reality, is tempted to say that the 'reality,' with which Professor Ladd deals, is only a metaphysical abstraction, quite of a kind with the 'stream of consciousness' conception of the Self, which is adopted as his model. If a 'stream of consciousness' had no channel in the bed-rock of real things to flow in, such a man might ask, How could any knowledge of the reality of the Self arise? From a common sense point of view, such a criticism would appear to be valid, since our idea of, as well as our term for, reality is obtained from the thing (Latin, *res*). The thingness of the thing is reality; this does not, however, invalidate the theory that the 'ground of things' may be, metaphysically, in the same class with the Self. The 'plain man' will, however, contend that it is by reason of its derivation from the thing, as its ground, that the conception of reality derives its meaning, and he will naturally infer that the putting of reality and the self into the same class will reduce self to a ground of a particular trans-subjective thing, viz., of its physical organism. Only when we take the point of view of the author, by adopting self in contrast to thing as our model of reality, do we reach the conclusion that reality is the selfness of the thing and of all things. This volume is of chief value to the scientific student for the light it throws, from this view point, upon some of his most difficult problems. Henry S. Williams.

New Haven, Conn., November, 1899.

DETERMINATION OF THE DENSITY OF WATER AT 4° C. BY THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES, 1899.

The interest attaching to the recent Report* on this subject is two-fold in that this constant is the connecting link between the metric units of capacity and mass as well as in most scientific volumetric measurements, and in that the present result bears the hall-mark of the institution that has given us our accurate standards of length, mass, and temperature. That the investigation was conducted by M. Guillaume, whose rare ability in quantitative research has become widely recognized through his memoirs as adjunct of the Bureau and through his admirable 'Thermométrie de Précision,' 'Unités et Étalons,' etc., is abundant guarantee that no refinement known to modern metrology has been omitted in this work.

After a discussion of the method, results, and sources of error, the report concludes:

"For the present it is probable that in adopting for the specific mass of water the value 0.99 995 or 0.99 996 the error committed will not exceed 2 centigrammes per kilogramme. We hope to be able by an exhaustive discussion of the measurements to reduce a little more these limits of uncertainty." (Translation.)

The method was the familiar one of weighing a solid of measured dimensions successively in air and in pure water from which the dissolved air had been withdrawn. Four hollow cylinders were used, two of bronze and two of brass. Their diameters ranged from 14.4 to 6.6 centimeters, and the height of each was about the same as the diameter. The corresponding weights of water displaced ranged from about 2 to 0.2 kilogrammes. The mean temperatures of the water when the weighings were made were about 8°, 8.°5, 9°, and 15°, these being selected, except the last, as giving about the maximum weight of displaced water. The linear dimensions of the cylinders were measured at a large number of systematically distributed points by the usual comparator. Sliding contact bars bearing reference marks were brought into contact with the cylinder at opposite ends of a diameter or of a height, and the distance between the marks measured by the microscopes and standard scale. This distance, less that found when the stops were in direct contact, gave the desired dimension. The density of the water was reduced to 4° by means of the tables of the expansion of water from the measurements of M. Chappuis (See *Procès-*

* Détermination de la masse du décimètre cube d'eau. Rapport préliminaire présenté au Comité International des Poids et Mesures dans la séance du 18 avril, 1899, par M. le Dr. Ch.-Ed. Guillaume.

verbaux for 1892, p. 147). The report clearly points out that the difficulty in reducing the uncertainty in the measurement by this method to even the amount here attained, 2cg. per kg. (2 in 100 000), lies mainly in the impossibility of obtaining by linear measurements the true volume of the cylinder.

Although the liter was originally defined as having the volume of one cubic decimeter, yet the International Bureau, in 1880, deemed it best to adopt as a provisional re-definition, the volume of one kilogram of water at 4° C., its temperature of maximum density. This was necessary for three reasons; first, the adoption of the platinum kilogram instead of the mass of the cubic decimeter of water at 4° as the standard of mass; second, the uncertainty as to the exact relation between the kilogram and the mass of the cubic decimeter of water; and third, the fact that the great majority of scientific measurements of volume or capacity are made by weighing the volume of water displaced or contained by the space to be measured. The scientific fraternity has unanimously adopted this practice. It is, therefore, pleasing to know from the above cited investigation that the discrepancy between the liter, as thus redefined, and the cubic decimeter, is but 5 parts in 100,000, or one two-hundredth of one per cent. No revision of past work and no correction of future results is, therefore, necessary where an error as large as one one-hundredth of one per cent. is unimportant; and this covers all engineering and the vast majority of scientific measurements. For work of an accuracy not exceeding one one-hundredth of one per cent. we may assume the volume of one gram of water at 4° C. to be one cubic centimeter, and the liter to be equal to the cubic decimeter. If the greatest possible accuracy is requisite, then we must add 5 parts in 100,000 to the volume as thus computed. So corrected, the results will probably be trustworthy within 2 parts in 100,000.

The following data, computed from the above specific mass of water, and from the relation, 1 inch = 2.54 000 $\overline{5}$ centimeters, derived from the Bureau's comparisons of yard and meter, are convenient:

One gram of water at 4° C. has a volume of 1.00 005 cc. (± 0.00 002 cc.).

One cubic foot of water at 4° C. (39.2° Ft. has a mass of 62.4252 lbs. (± 0.0012 lbs.).

One cubic inch of water at 4° C. has a mass of 252.880 grains (± 0.005 grains).

S. W. HOLMAN.

BOOKS RECEIVED.

System der Bakterein. W. MIGULA. Jena, Fischer. 1900. Pp. x + 1068. 18 Plates. Mark 30.

Practical Exercises in Elementary Meteorology. R. DEC. WARD. Boston, Ginn & Co. 1899. Pp. xiii + 199.

A Century of Science and other Essays. JOHN FISKE. Boston and New York, Houghton, Mifflin & Co. 1899. Pp. vii + 477. $2.00.

SCIENTIFIC JOURNALS AND ARTICLES.

Journal of Physical Chemistry, November. 'Thermal Coefficients,' by J. E. Trevor; 'On the Theorems of Robin and of Moutier,' by Paul Saurel—both mathematical papers; 'Hydrates in Solution,' by Wilder D. Bancroft, a criticism of Nernst's deduction that the percentage of hydrated substance in a dilute solution is independent of the concentration.

Bird Lore for December brings the first volume to a close. Witmer Stone contributes an interesting description of 'A Search for the Rudy Island (N. J.) Crow Roost,' and W. E. Cram, 'Winter Bird Notes from Southern New Hampshire.' A. A. Crolius tells 'How the Central Park Chickadees were Tamed,' and under the caption 'The Surprising Contents of a Birch Stub,' Frank M. Chapman describes a family of Chickadees, while P. B. Peabody furnishes two pictures of 'Richardson's Owl,' with accompanying text. The most important article, 'Humanizing the Birds,' by Caroline G. Soule, is a timely protest against ascribing to the birds human qualities that they do not possess. There are numerous notes, reviews and reports from Audubon Societies.

The Osprey for November commences with an article on the 'Breeding of the Fish Crow in Pennsylvania,' by Frank L. Burns, and this is followed by a short account of 'Dusky, or Some Traits of a Canary Bird,' by Miriam Zieber. The main paper is a reprint of a very interesting

description of 'The Shearwaters and Fulmars as Birds and Bait,' by J. W. Collins. W. P. Lemmon describes a 'Nest of Duck Hawks in New Jersey,' and the balance of the number is filled with notes and reviews.

The Macmillan Company announces that it will commence the publication on January 1st of the *International Monthly*, a magazine of contemporary thought edited by Mr. Frederick A. Richardson with a distinguished advisory board. The magazine proposes to give in each number a comparatively few articles of considerable length, and science is to have a prominent place. Thus the five articles in the first number include, 'Influence of the Sun on the Formation of the Earth's Surface,' by Professor N. S. Shaler, and 'Recent Advance in Physical Science,' by Professor John Trowbridge. The members of the advisory board as it is thus far organized are:

History: J. H. Robinson, Columbia University; George Monod, College of France; Karl Lamprecht, University of Leipsig.

Philosophy: Josiah Royce, Harvard University; Xavier Léon, Paris; Paul Natorp, Marburg University; George F. Stout, Oxford.

Psychology: Edward B. Titchener, Cornell University; George F. Stout, Oxford; Th. Ribot, Paris; Oswald Külpe, Leipsig University.

Sociology: Franklin H. Giddings, Columbia University; Gabriel Tarde, Paris; Georg Simmel, Berlin University; J. S. Mackenzie, Cardiff, Wales.

Comparative Religion: C. H. Toy, Harvard Universersity; Jean Réville, College of France; F. B. Jevons, University of Durham; C. P. Tiele, University of Leiden; Ths. Achelis Bremen.

Literature: William P. Trent, University of the South; Richard Garnett, London; Gustave Lanson, Paris; Alois Brandl, Berlin University.

Fine Art: John C. Van Dyke, Rutgers College; Georges Perrot, Paris University; Adolph Fürtwangler, Munich University.

Biology: Charles O. Whitman, University of Chicago; Raphael Blanchard, College of France; E. B. Poulton, Oxford University; Wilhelm Roux, Innsbruck University.

Medicine: D. B. St. John Roosa, Pres. Graduate School of Medicine; Sir Thomas G. Stewart, University of Edinburgh; Leop. Panas, College of France; Carl Von Noorden, Frankfurt a. M.

Geology: Joseph Le Conte, University of California; Sir Archibald Geikie, London; Hermann Credner, Leipsig University.

Departments of Physics and Industrial Arts are to be added.

The October number of the *Kansas University Quarterly* contains a list of the scientific publications of the faculty and students of the State University. This list, which numbers some 800 books and papers, includes only those publications on natural and physical science and mathematics.

SOCIETIES AND ACADEMIES.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF ASTRONOMY AND PHYSICS.

At the meeting of the Astronomy and Physics Section of the New York Academy of Sciences, on Monday evening, November 6, 1899, Professor J. K. Rees, of Columbia University, gave a lecture, illustrated by lantern views, on 'November Meteor Showers.' Among other things, the speaker said that one of the theories of the origin of some meteors was that they were at some time ejected from the sun or moon, earth, or other planets, by volcanic explosions, and if from the earth, they traveled in an orbit that intersected that of the earth. The later theories which identify meteor streams with comets or the remains of comets, seem most satisfactory. Those meteors which reach the earth have a large percentage of nickel in their composition, and show when they are polished, a peculiar and characteristic crystalline structure. A great many of these meteors reach the earth on an average each day, as many as ten million or more, it has been estimated. Interplanetary space is full of them. During the meteor showers, this number is greatly increased. During the shower of 1833, at one place on the earth as many as 240,000 were estimated to have been visible during eight hours.

Historical records seem to show that showers of meteors have been seen at intervals of thirty-three years in the fall of the year for some time back. In 1799 Humboldt saw one from the Andes Mountains. In 1833 there was another. Professor H. A. Newton of Yale, after investigating the subject, predicted another in 1866,

which came as predicted. Professor Newton and Professor Adams of England calculated that there was a large bunch or collection of these meteors traveling around the sun with an orbit of about thirty-three and a quarter years. This orbit at one point intersected the orbit of the earth. It was later shown that this orbit was practically identical with that of Tempel's comet of 1866. Three other similar cases of a connection between the meteor showers and comets have been found, and these seem to indicate either that the showers and comets are identical, or that the meteors are parts of a disintegrated comet.

In observing the meteors, the best results are obtained from photographs. Professor Elkin of Yale has a battery of cameras fastened to an equatorial axis, each camera covering a distinct part of the heavens. By means of two such arrangements several miles apart, the exact distance between the two stations being known, it will be possible to get photographs from which can be deduced with accuracy the path of the meteors, the velocity, and the distance from the earth.

The Columbia University Observatory was obliged, on account of the sale of the old observatory site and the storage of the instruments, to make arrangements for observing the expected shower from other places. Col. P. S. Michie of West Point placed the observatory there at the service of Professor Rees, and Mr. C. A. Post of Bayport offered his time and instruments. A report on the work done during the week, November 13th to 18th, will be presented to the Academy. WM. S. DAY.

Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting of November 25th, Mr. Charles Barnard presented a paper on 'Some Recent Changes in the Shore Line of Nantucket.' These changes have become apparent by comparison with the outlines indicated in Shaler's map of 1888 (Bull. No. 53, U. S. Geol. Survey). The shore line there represented as nearly straight, from a point just beyond the Range Lights to Brant Point, in the harbor, has become materially changed by a rapid advance of the beach on each side, so that the original shore end of the breakwater is lost to sight in the sand or covered by buildings.

On the north shore, beyond the Apron Beach, the sea has steadily advanced upon the land, the increase of material at the breakwater having been evidently derived in large part from the bluffs.

At the eastern end of the harbor the narrow beach, styled the Haulover, between the main island at Manumet and the shore end of Great Point, was broken through by the sea in the storm during the night of December 16, 1896, and the opening has now become an inlet a mile in width, with a depth of 11 feet at low water, each end of the remaining beach having been bent back into the harbor in the form of a curved hook. The entrance of the tide through this inlet has caused a decided increase in the five narrow bars of sand, which extend like finger points from the shore of Coatue Beach. It does not appear to have seriously affected the current at the breakwater, nor reduced the scouring action of the tides at that point; but shoals seem to be growing at about one-third the distance between the harbor and the port entrance, at the slackwater caused by meeting of the tides from east and west.

The eastern shore, from the harbor south, shows a rapid destruction by the sea, and at Squam Pond a river of beach sand has been swept in.

At Sankaty Light the apron beach has very considerably increased, particularly at Siasconset, and to the south and west, the width of the beach now reaching about the third of a mile.

A similar advance of the sea is shown along the south shore, though to a less degree than on the east, the wastage of both shores having contributed to build out the apron beach at Siasconset.

The subject was further discussed by Professors R. E. Dodge, J. J. Stevenson, H. L. Osborn, J. F. Kemp and others.

On motion by Professor Stevenson, a committee of three was appointed by the Academy to prepare resolutions in reference to the recent death of its distinguished honorary member, Sir William Dawson, of Montreal.

ALEXIS A. JULIEN,
Secretary of Section.

SECTION OF BIOLOGY.

The regular meeting took place on November 13, 1899, Professor Frederic S. Lee presiding. The following papers were then presented:

'On the Relation of the Centra and Intercentra in the Cervical Vertebræ of Lizards, Mosasaurs and *Sphenodon*,' by H. F. Osborn.

'The Discovery of a Mastodon's Tooth and Remains of a Boreal Vegetation on Staten Island,' by Arthur Hollick.

'A Report of the New York University Expedition to the Bermuda Islands in the Summer of 1899,' by C. L. Bristol.

Professor Osborn called attention to the confused statements relating to the cervical vertebræ in the Lizards, Mosasaurs and *Sphenodon*, and pointed out that both Gegenbaur and Wiedersheim, the principal German authorities on the Comparative Anatomy of Vertebrates, failed to recognize clearly the important part played by intercentra of the neck region. He then, commencing with *Sphenodon*, pointed out that we have a series of *intercentra* or intervertebral ossicles, extending throughout the whole length of the backbone, but considerably modified by a coalescence with the atlas and axis. In *Platecarpus*, the Cretaceous Mosasaur, on the other hand the intercentra of the axis and atlas are entirely free and separate, retaining their primitive wedge-shaped form, while the centrum proper or odontoid process is also free from the axis; in the remaining cervicals the intercentra are secondarily shifted forward upon the hypapophyses. *Varanus*, the monitor lizard, exhibits a still greater extension of these hypapophyses with the intercentra placed at their tips. In *Cyclurus*, on the other hand, the intercentra are still in their primitive position between the vertebræ. There is no question, therefore, that true intercentra are very important elements in Lizards and Mosasaurs, and that they are secondarily modified partly by coalescence with the atlas and partly by adhesion to the hypapophyses, this showing a complete change of function.

The leading facts in Professor Hollick's paper are as follows:

In the Moravian Cemetery at New Dorp, Staten Island, immediately in the rear of the Kunhardt Mausoleum, was a swamp, which covered a superficial area of about 3,600 square feet. A small pool of water accumulated towards the center in time of rain and dried out during drought. The margin was a quaking bog of peat and sedges. It occupied a morainal basin, located about 1,200 feet from the southern edge of the moraine and about 120 feet above tide level.

Last summer, in the course of certain improvements in the development of the cemetery, the swamp was drained and the bog muck was dug out, so that at the present time the morainal basin is entirely free of water and mud.

During the progress of this work the organic remains, animal and vegetable, brought to light show that the basin was the site of a Quaternary pond. The surface deposit was of fine peat and a coarse peat, composed of various kinds of swamp vegetation. Below this was a fine organic mud, containing trunks and branches of trees, to a depth of about five or six feet. Below this was a black, sandy silt, distinctly stratified, and containing numerous cones and small twigs of white spruce (*Picea Canadensis* (Mill.) B. S. P.), a tree of northern range, which does not now extend further south than northern New England and the Adirondacks. Below the cones, at a depth of about 23 feet, was found a mastodon's molar.

The maximum depth of the entire deposit was about 25 feet and bore every indication of having been laid down in still water, in a continuous and unbroken series of layers; and, inasmuch as it was in a morainal basin, it must all have been post-morainal in age.

A considerable amount of charred wood was also found in connection with the cones, presumably indicating the presence of man. The probabilities are that a pond was formed in the morainal depression immediately after the recession of the ice sheet, and that this pond was a receptacle for silt, dust and decaying vegetation ever since, the accumulations finally filling it up and converting it into a swamp with a little pool of casual water in the middle.

The third New York University Expedition to Bermuda left New York on May 27th, via the Quebec Steamship Company's steamer *Orinoco*, and the last members to return arrived

on August 1st. The party consisted of Professor C. L. Bristol, Messrs. F. W. Carpenter, C. E. Brush, Jr., F. Erdwurm, of the graduating class; Messrs. Hill, Magnus and Wooley of the present Junior class, and Mr. A. Benton Müller.

The reconnaissance work of the two former years was continued from White's Island in Hamilton Harbor as headquarters. The buildings on the islands afforded far better facilities for laboratory work than was obtained on the other trips, and also brought the party nearer to the south shore and the Great Sound. An important feature was a series of pools constructed above tide level and supplied with plenty of running sea-water, in which a day's 'catch' could be examined alive at leisure. A naphtha launch and a small yacht gave the necessary facilities for collecting. The principal work was reconnaissance and many new forms were found among the *Crustacea*, *Echinoderms*, *Coelenterates*, *Tunicates*, *Mollusca*. Perhaps the most important single trip was that made to North Rock, an isolated fragment of the old atoll-shaped reef, about nine miles out at sea. At dead low tide a small area is laid bare but almost awash, and attainable only in the smoothest of water. Here the life of the ocean swarms and offers rare opportunities for study. As in the former years a large number of the showy fishes that abound in the coral reefs were brought home alive for the New York Aquarium. Notwithstanding the sudden fall of temperature at the northern edge of the Gulf Stream the system of regulation of the temperature is now so perfect that less than one per cent. die on the voyage. A pair of green parrot fishes of large size, and a large green muray about eight feet long were the most conspicuous among them, and are living and in good health at this date.

FRANCIS E. LLOYD,
Secretary.

TORREY BOTANICAL CLUB, OCT. 25, 1899.

THE scientific program opened with a paper by Dr. D. T. MacDougal on 'The Mycorrhiza of *Cephalanthera*,' describing the general characters of this Pacific coast plant, with special reference to its symbiotism, and with exhibition of specimens in alcohol. Dr. MacDougal's specimens form probably the most complete examples of its root system ever procured, the plant growing among matted hemlock roots and very difficult to get at. Discussion by Dr. Britton of the taxonomic relations of *Cephalanthera* followed.

The second subject of the evening was that of Ferns, 'Notes on Ferns' were presented by Mrs. Britton, with specimens and lantern views. Dr. Underwood exhibited some very large examples of *Botrychium lanceolatum* from the foot of Mt. Rainier, reaching about 1 foot high, including roots, and with frond nearly 3 inches in length.

Mr. W. N. Clute spoke of finding *Dryopteris Goldieana* at Bedford Park, and of continued discoveries of *Dryopteris simulata*, usually in company with *Woodwardia areolata*.

Mrs. Britton spoke of the association of *Dryopteris simulata* on the Pocono with *Rhododendron maximum*, in very different surroundings; and called attention to its distinctly blue-green coloring.

Mr. Clute reported finding last July a new station for *Schizæa pusilla* at Allen's Bridge, N. J., on the east branch of the Wading river, in quantity, observed last July. The fertile fronds of the last year were then still remaining on the plant. Sterile fronds were coiling about neighboring stems as if with a trace of the climbing habit of its relative, *Lygodium*. This coiling tendency, added Dr. Britton, has occasioned the name Curly-grass, which was found in use in New Jersey for the *Schizæa*.

The Secretary referred to the successful transplanting of *Schizæa* into a locality near Lakewood, N. J., by Miss R. W. Farrington.

Miscellaneous notes constituted the remainder of the program. The Secretary made some remarks upon singularities in the distribution of *Aster Schreberi*, a species described by Nees in 1818, from a single plant, and afterward omitted by botanists, until the publication of the Illustrated Flora. The abundance of this species, which he finds characteristic of the Schoharie drainage-basin of the Catskills, contrasts strangely with its absence from other parts of that region.

Judge Brown reported finding *Solidago odora* on high ground near Sam's Point, late in the season, many scattered plants blooming at about 2,000° altitude.

Dr. Britton remarked that this forms an interesting addition to the number of coast plants found in the Shawangunk range. It has been claimed that the breaking up of sandstone rocks there has produced a sandy soil sufficiently similar to that of the seashore to permit the growth of certain arenophilous plants usually found only on the coast.

Dr. T. F. Allen spoke of a specimen of *Rhus vernicifera*, the lacquer tree of Japan, which is growing luxuriantly on his farm in Connecticut. It resembles our swamp sumach, *Rhus venenata*, in appearance, and is becoming a handsome tree. Some of his family who are sensitive to Rhus poisoning find it necessary to avoid going near it.

Dr. Britton also reported a gift to the Botanic Garden of about 200 volumes which had belonged to the botanist, David Hosack. They are in excellent condition, and some of them extremely rare. EDWARD S. BURGESS, *Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON, 312TH MEETING, SATURDAY, NOVEMBER 19TH.

MR. F. A. LUCAS read a 'Letter from H. H. Field Concerning the Concilium Bibliographicum, and the Proposed Catalogue of the Royal Society,' calling attention to the expense of the proposed publication, even though no card catalogue was issued, and stating that the Concilium could carry out the entire scheme at a less cost than the incomplete publication proposed by the Royal Society.

Mr. Frederick V. Coville read a paper on 'The Botanical Explorations of Thomas Nuttall in California,' showing that the dates on which Nuttall is stated to have visited various localities were erroneously given.

Professor Barton W. Evermann described 'A Physical and Biological Survey of Lake Maxinkuckee,' giving the various problems whose solution was desired, and the methods employed for soundings, obtaining the temperature, and studying the plankton of the lake.

O. F. COOK, *Secretary.*

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE November meeting of the Science Club of the University of Wisconsin was held on the 21st instant, the Vice president, Mr. Edward Kremers, in the chair. The programme of the evening was a paper by Mr. Louis Kahlenberg on 'The Present Status of our Knowledge of Solutions.'

After an exposition of the modern theories of solution and of electrolytic dissociation, the speaker pointed out that his recent researches on non-aqueous solutions have shown that there are solutions that conduct electricity in which, according to molecular weight determinations there is no dissociation, and that furthermore, the molecular conductivity in some solutions does not change with the dilution, and that in others it decreases as the volume increases. These facts can not be harmonized with the theory of electrolytic dissociation.

In the criticism of the general theory of solutions it was emphasized that the solvent does not act merely as so much space, but that it has a far more important function, the very act of solution itself depending on a mutual interaction of solvent and solute.

The paper was discussed by Messrs. B. W. Snow, H. L. Russell, E. Kremers and C. F. Burgess. WM. H. HOBBS.

DISCUSSION AND CORRESPONDENCE.

AN ALIEN CLEMATIS IN NEW MEXICO

LAST July I found an interesting and peculiar *Clematis* growing along the road-side in the town of Las Vegas, N. M., apparently wild. It was clearly related to the *Clematis* (*Atragene*) *occidentalis* (Hornem.) of the adjacent mountains, but still quite distinct. It did not come into full flower until the *C. occidentalis* was over, and the flowers were yellow instead of blue or white. Careful comparisons showed that the plant was different from anything known in America, so I drew up a description, under the name of *C. crux-flava*, 'the yellow cross.' During the rest of the summer I examined a good deal of the country near Las Vegas, and nowhere was the new *Clematis* to be seen, except within the limits of the town. A very vigorous plant was found growing in a garden, but nobody knew how it got there. These facts suggested an alien, so I sent specimens to Dr. B. L. Robinson at Cambridge, and to Kew Gardens, requesting that they might be compared with the Asiatic species. From both places in due time came the reply

that the plant was *Clematis orientalis* L. ; from Kew the further information was sent that it was a variety of the species, exactly agreeing with specimens from the N. W. Himalayas.

As the plant is apparently with us to stay, it may be worth while to give the description of it, based on Las Vegas material.

Clematis orientalis, variety—Low straggling climber; stems slender, purplish at the nodes; leaves, including petioles, 7 to 12 cm. long, with five leaflets, which are rather thick, perfectly glabrous, a somewhat glaucous green, more or less lanceolate in outline, the terminal one often linear-lanceolate, the lateral ones sometimes ovate-lanceolate, all more or less coarsely and irregularly serrate towards the base, or even lobed, the upper leaves especially having narrow leaflets, distinctly lobed at the base, the lobes pointed and often notched ; in a well developed leaf the terminal lobe is about 4 cm. long. Buds pale greenish-yellow, obpyriform, nodding, 4-angled; flowers at first nodding, ultimately erect; sepals four, pale sulphur-yellow with a greenish tint, rather thick, recurved at tips, 7-nerved, nearly glabrous, perfectly so below except edges, but above with scanty white woolly hairs, and the lateral margins, which are bent inwards, quite conspicuously white-woolly towards the tip; apex of sepal truncate in lateral view, with a linear green process, 2 mm. long, at the lower corner of the truncation. Length of sepal about 23 mm., breadth 10 mm. Stamens 32, anthers $4\frac{1}{2}$ mm. long, filaments about 6 mm., broad and flattened, especially the inner ones, glabrous with only a few hairs on the margins. Outer filaments tinged with purplish. No staminodes. Fruit a globular head with the usual long plumose tails, about 4 cm. long, the carpels also hairy, borne upon a honeycombed hairy receptacle. The persistent styles in the fruit are reddish, and the other long hairs silvery-white.

The naturalization of a Himalayan *Clematis* in the mountains of New Mexico suggests the possibility that other plants from the same region might do well if introduced here, some of them being perhaps of economic value.

T. D. A. COCKERELL.

MESILLA PARK, NEW MEXICO,
November 25, 1899.

NOTES ON INORGANIC CHEMISTRY.

THE problem of the structure of the carbon molecule has attracted the attention of not a few chemists, though little progress has been made toward its solution, owing to the difficulty of obtaining soluble bodies of definite composition by the action of reagents upon any form of carbon. Sometime since, L. Staudenmaier discovered a rapid method of oxidizing graphite to graphitic acid, and a continuation of this work is described in the current *Berichte*. Graphitic acid appears not to be a true acid, but a substance of a quinone nature. By heating it is converted into a simpler compound which the author calls pyrographitic acid, from which other derivatives may be formed. Among the oxidation products is mellitic acid $C_6(COOH)_6$. From the analogy furnished by the oxidation of naphthalene to phthalic acid, it would appear that graphitic acid and hence graphite contains three naphthalene groups united together into a benzene nucleus.

In the study of non-aqueous solutions more work has been done on ammonia as a solvent than on any other liquid. The work of E. C. Franklin and others shows that many salts dissolve readily in liquid anhydrous ammonia and are electrolytically dissociated. According to Franklin, liquid hydrogen sulfid appears not to act in this manner as a solvent, and I know of no experiments with liquid hydrochloric acid. Great interest attaches to a series of experiments described by P. Walden, of Riga, in the *Berichte*, on liquid sulfur dioxid as an inorganic ionizing solvent. It is the more remarkable, as the solvent contains no hydrogen. As far as Walden's experiments have yet gone, the halid salts have been found to dissolve readily in liquid sulfur dioxid and metathetical reactions take place in the solution. Organic substances of very different compositions dissolve readily, and often though solvent and solute are colorless, the solution is colored. A number of substances were used for determination of molecular weight by the boiling point method. The solutions appear to be quite different from the aqueous solutions, showing the molecular weight in several instances double what would be expected. The article is an interesting contribution to the chemistry of solutions.

The last number of the *American Chemical Journal* contains a paper by Dr. G. P. Baxter, of Harvard University, on the occlusion of hydrogen by cobalt and other metals. Statements in literature regarding this subject vary very much, but Dr. Baxter claims that this is due chiefly at least to the different degrees of purity of the metal. Ingot cobalt, or very pure cobalt, when very finely divided, has the power of occluding hydrogen to a very slight extent. Most of those cases where there is a large amount of hydrogen absorbed are, at least, in part due to the presence of impurities in the cobalt used. Nickel, silver and copper act similarly to cobalt in occluding but small quantities of hydrogen. Indeed, it is questioned whether silver actually occludes any hydrogen.

Japanese farms are, to a large extent, exhausted of phosphoric acid, so that the discovery of phosphate beds in that country is very welcome. This discovery is described by K. Tsuneto in the *Chemiker Zeitung*. The phosphate beds which are on island Kinshu are largely lime and sand running only up to 20% phosphate; but this can be very successfully used in lieu of better material and will prove of great service to Japan. The remainder of the material of the phosphate beds seems to be a sand cemented together by limestone. Some fossil remains are present. J. L. H.

CURRENT NOTES ON METEOROLOGY.

LECTURES ON METEOROLOGY.

In the Public Educational Course, now being given in Baltimore, under the auspices of the Johns Hopkins University, a series of fifteen class lectures, by Dr. Oliver L. Fassig, Instructor in Climatology in the University, is announced. These lectures are to come on Saturday morning, beginning about the middle of December, and are intended especially for teachers. The fee for the course is $3, and with the additional privilege of class work, consisting of written exercises and final examination, the fee is $5. For regular attendance, satisfactory class or laboratory work, and final examination, a simple certificate will be awarded to successful students. The attendance at this educational course this year is to be about eighty-five. The subjects of Dr. Fassig's lectures are as follows: I., II. The Temperature of the Atmosphere; III., IV. Forms of Water in the Atmosphere; V. The Weight and Extent of the Atmosphere; VI., VII., VIII. The Movements of the Atmosphere; IX. Weather; X. Climate; XI. Do Climates Change? XII., XIII. Fortelling the Weather; XIV. The Work of a National Weather Bureau; XV. Two Centuries of Progress in Meteorology.

PHYSIOLOGICAL EFFECTS OF ANTARCTIC COLD AND NIGHT.

Dr. Frederick A. Cook, Surgeon of the *Belgica* expedition to the Antarctic, writes of some of the incidents of the voyage in *McClure's Magazine* for November. The physiological effects, noted as a result of the darkness and cold of the Antarctic night, are thus described: "The long darkness, the isolation, the tinned foods, the continued low temperature, with increasing storms and a high humidity, finally reduced our systems to what we will call polar anæmia. We became pale, with a kind of greenish hue. * * * The stomach and all the organs were sluggish, and refused to work. Most dangerous of all were the cardiac and cerebral symptoms. The heart acted as if it had lost its regulating influence. Its action was feeble, but its beats were not increased until other dangerous symptoms appeared. Its action was irregular, feeble, and entirely unreliable throughout the night. The mental symptoms were not so noticeable. The men were incapable of concentration and unable to continue prolonged thought. One sailor was forced to the verge of insanity, but he recovered with the returning sun." Similar effects have been noticed in the Arctic, and hence show a well-marked series of physiological changes which take place under the peculiar conditions which surround Arctic and Antarctic explorers during the long polar night.

PHYSIOLOGICAL EFFECTS OF HIGH ALTITUDES.

The September number of the *Zeitschrift für Luftschiffahrt* contains a short paper by Dr. Mertens on the physiological effects of high altitudes; the suggested causes of these various effects, and possible remedies. The article gives a compact summary of this interesting problem. It is to be noted that Dr. Mertens

uses the term *Höhenkrankheit* rather than *Bergkrankheit.* This seems a reasonable change. The latter word really includes only the physiological effects experienced by mountain climbers, while the former includes all the effects of diminished pressure, whether noted by mountain climbers, who are still on *terra firma*, or by aëronauts, who are carried above the surface of the earth in the car of a balloon.

R. DEC. WARD.

HARVARD UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR E. E. BARNARD of the Yerkes Observatory, University of Chicago, sailed from New York on December 9th for England. He intends to arrange for a lens for the Bruce photographic telescope.

PROFESSOR EDWARD ORTON, JR., has been appointed state geologist, of Ohio, to succeed his father, the late Dr. Edward Orton. Professor Orton served as an assistant on the Ohio Survey, studying the distribution of the coal measures, and later prepared the excellent reports on the clay and clay industries of the State which were published in Volumes V. and and VII. of the Geological Survey of Ohio and in the Reports of the National Brick Manufacturer's Association. Since 1894 he has been the director of the department of clay-making and ceramics in the Ohio State University in which is given the only four-year course in ceramics in this country. This appointment ensures the continuance of the excellent work in economic geology which has characterized the later Geological Reports of Ohio.

DR. JOKICHI TAKAMINE, of the University of Tokio, Japan, known for his researches on digestive ferments, is at present on a tour of inspection of the larger educational institutions of the United States. He has been sent by the Japanese government to examine the scientific work and methods of American universities.

THE *New York Herald* has received a cablegram stating that M. Daniel Osiris has given a large endowment to the Institute of France to provide a triennial prize of 100,000 fr. to be awarded for a great scientific discovery or work of art. Surgical or medical discoveries are to be especially considered.

PROFESSOR DR. FÖRSTER of the Mülhausen *Gymnasium* has received a call from the Dutch Government to geological research in Sumatra. He will be absent about one year and a half.

SIR WILLIAM MACCORMAC, the eminent British surgeon, who it will be remembered volunteered his services at the seat of war in South Africa, arrived at Cape Town on November 20th.

THE Special Board for Biology and Geology, of Cambridge University, have adjudged the Walsingham medal for 1899, to H. H. W. Pearson, B. A., Gonville and Caius College, for his essay entitled 'The Botany of the Ceylon Patanas,' and a second Walsingham medal to J. Barcroft, B. A., Fellow of King's College, for his essay entitled 'The Gaseous Metabolism of the Submaxillary Gland.'

MR. W. F. COOPER, Clare College, Cambridge University, has been nominated by the Special Board for Biology and Geology to occupy the University table at the Zoological Station at Naples until February 1, 1900.

DR. L. A. BAUER, on October 25th, was the guest of the Royal Geographical Society of St. Petersburg. At the close of the meeting he exhibited various maps relating to the magnetic survey of the United States and Alaska in general, and of the special magnetic survey of Maryland.

MR. HENRY P. WALCOTT, of Cambridge, has been elected president of the Massachusetts Forestry Association.

THE death is announced of Professor Francis Guthrie at the age of sixty-eight. He was for many years professor of mathematics in the South African College, and made valuable contributions to the botany of South Africa.

PROFESSOR P. KNUTH died at Kiel on October 30th, at the age of forty-five years. He was well known for his researches on cross-fertilization.

WE also regret to learn of the death of Professor R. Yatube, the Japanese botanist.

IN accordance with the German custom the former pupils of Dr. William H. Welch, pro-

fessor of pathology in the Johns Hopkins University, will mark the occasion of his twenty-fifth year as teacher and investigator, by dedicating to him a volume of their scientific contributions. Some seventy-five students have undertaken investigations under Dr. Welch's leadership and nearly half of these will contribute to the volume. Dr. F. P. Mall is the secretary of the committee of publication and to him communications and subscriptions should be addressed. The committee of publication consists of: A. C. Abbott, University of Pennsylvania; L. F. Barker, Johns Hopkins University; Wm. T. Councilman, Harvard University; Simon Flexner, University of Pennsylvania; W. S. Halsted, Johns Hopkins University; A. C. Herter, University and Bellevue Hospital Medical College, New York; Wyatt Johnston, McGill University; F. P. Mall, Johns Hopkins University; Henry F. Osborn, Columbia University, New York; Walter Reed, Army Medical Museum, Washington, D. C.; Geo. M. Sternberg, Surgeon General's Office, Washington, D. C.

At the approaching meeting of the American Society of Naturalists, which will be held at New Haven on December 27th and 28th, a lecture will be given on Wednesday evening by Professor A. E. Verrill on 'The Geology and Natural History of the Bermudas.' Afterwards there will be a reception to members in Alumni Hall. The speakers in the discussion on 'The Position that Universities should take in regard to Investigation' will include Professors Thomas Dwight, R. H. Chittenden, William B. Scott and Joseph Jastrow. The address of the president, Professor W. G. Farlow, will be given, as we have already stated, on Thursday evening.

The Royal Society held its anniversary meeting on November 30th. In accordance with custom the president, Lord Lister, delivered an address in which he paid special attention to inoculation against the plague. The leading officers were reëlected, except that Dr. T. E. Thorpe was elected foreign secretary and the medals were conferred as already announced. The Council in its annual report referred especially to the preliminary conference on an International Association of Scientific Academies, the proposed International Catalogue of Scientific Literature, and the National Physical Laboratory. The annual dinner was held in the evening and speeches were made by Lord Lister, Lord Rayleigh and others.

The American Chemical Society, on petition of those of its members who reside in Michigan, is now establishing a local section for that State. The headquarters are to be in Ann Arbor, and the meetings are to be held alternately in Detroit and at the University of Michigan.

The inauguration of Professor geistl. Rath Dr. Bach as Rector of the University of Munich, took place on November 25th. His address was entitled '*Verhältniss von Bildung und Arbeit.*'

The memorial lecture established by the Liverpool Society of Chemical Industry in memory of Dr. Ferdinand Hurter, was given for the first time by Professor C. Lunge, of Zurich, whose subject was 'Impending Changes in the General Development of Industry and particularly in the Alkali Industry.'

Mr. Charles Vernon Boys, F.R.S., is to deliver the annual course of Christmas lectures, specially adapted to young people, at the Royal Institution this year. He has chosen as his subject: 'Fluids in Motion and at Rest.' The lectures, which will be six in number, will commence on Thursday, December 28th, at three o'clock.

It is proposed to hold an International Congress of Tuberculosis in May, 1901.

Nature states that the budget of the German Imperial home office includes an item of 15,000 Marks for the International Catalogue of Scientific Literature.

The New York Board of Estimate has refused the request of the New York Zoological Society for an additional appropriation of $7,500 and the Mayor has refused to reconsider the question.

The subjects proposed by the Boston Society of Natural History for the Walker prizes in 1900 are (1) Stratigraphy and correlation of the sedimentary formations of any part of New England; (2) A study in paleozoic stratigraphy and correlation.

THE New York Zoological Society has issued a Popular Official Guide to the New York Zoological Park as far as completed, with maps, plans and illustrations. It contains a brief account of the Society, its origin and aims; tells how to reach the Park, describes the general topography of the grounds and the animals it now contains. There is much information concerning the range, size and habits of the animals, their former abundance or present scarcity, and the accompanying illustrations are very good.

A TELEGRAM has been received at the Harvard College Observatory from Professor Kreutz at Kiel Observatory, stating that a planet of the tenth magnitude was discovered by Charlois Dec. $4^d.377$ Greenwich Mean Time in R. A., $4^h\ 37^m\ 56^s$ and Dec. $+14° \ 13'$.

Daily motion in R. A. $-14'$
" " " Dec. $+\ 4'$

A TOPOGRAPHICAL map of Greater New York, 24 x 28 feet in size, and costing about $10,000, is being prepared for the Paris Exposition. It is expected that the map will subsequently be placed in the New York Public Library.

THE corals collected by the Beal-Steere Expedition and given to the University of Michigan have been mounted and permanently shelved in the museum. The collection includes several hundred specimens taken from the Pacific Ocean near the Philippine Islands and the island of Formosa. As far as possible each specimen has been placed in the position in which it originally grew.

WE learn from the *British Medical Journal* that of the three members of the Malaria Commission which proceeded to British Central Africa in the early part of the year, two, Messrs. Christophers and Stephens, have returned. Dr. Daniels remains for a further term in Central Africa. We understand that Messrs. Christophers and Stephens will almost at once proceed to the West Coast of Africa, in the first instance to Sierra Leone, where there should be no lack of material for studies both in malaria and in blackwater fever. Hitherto the work of the Commission has been hampered by lack of clinical material. It is easy to understand how, in the scanty and scattered European population of British Central Africa, although blackwater fever is the most frequent cause of death, such a concentration of cases as would best suit the purposes of the Commission might be difficult to effect. In the larger and more concentrated European populations to be found in West Africa it is to be hoped that in this respect the conditions will be more favorable to the work of the Commissioners.

REUTER'S AGENCY is informed that Dr. Carl Peters, in a letter dated Umtali, October 13th, just to hand, announces that during the rainy season, when practically no prospecting work was possible, he intended to come to England. He adds: "I expect to arrive about the middle of December, accompanied by Umtete, the brother of the famous chief Macombe. I am leaving my staff out here. One mining engineer and a trader are left at the Fura station, near the Zambesi, and also at the Inyanga station, near Umtali. I am in first-class health, but am feeling a little run down in consequence of the marching, exploring, irregular food, etc. I have evidence that can prove we have really discovered the Fura of the old reports." In explanation of this, Reuter's Agency is informed that Dr. Carl Peters's expedition was mainly based on an old atlas published in Amsterdam in 1705, with French text, the author being unknown. In this atlas it was stated that "near this place (south of the Zambesi and near the river Manzoro, now Mazoe) is the great mountain of Fura, very rich in gold, which some people regard as a corruption of the Ophir." This view was also held by the Portuguese writer Couto, who was quoted by Theodore Bent in his 'Ruined Cities of Mashonaland.' With regard to Fura, Couto said: "The richest mines of all are those of Massapa, from which the Queen of Sheba took the greater part of the gold which she went to offer to the Temple of Solomon, and it is Ophir, for the Kaffirs call it Fur and the Mons, Afur." Dr. Peters states that no traveler had visited this region within the last 200 years. He has now rediscovered ancient ruins of Semitic origin, including fortifications and what he regarded as a temple or storehouse. The whole region is practically uninhabited. He also claims to have found distinct traces of ancient gold working there.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Thomas Armstrong, of Plattsburgh, Union College is to receive between $100,000 and $150,000. It is required that the college shall endow a chair of sociology and offer a certain number of annual prizes and scholarships for the sons of Clinton County farmers.

MR. AUGUSTUS LOWELL has given the Massachusetts Institute of Technology $50,000, to be used as the nucleus of a fund, the income of which shall be used for the benefit of the teaching staff of the Institute in cases of illness, death or retirement.

DALTON HALL, the chemical laboratory of Johns Hopkins University, has been damaged by fire. The top floor was almost destroyed and much injury was caused to the lower floors by water. The loss being estimated at $12,000.

DR. THOS. H. MONTGOMERY has been appointed assistant professor of zoology in the University of Pennsylvania.

AT Cambridge University Mr. E. A. N. Arber, B.A., Trinity College, has been appointed demonstrator in paleobotany in the place of Mr. H. Woods, resigned.

DR. WILHELM MUTHMAN, assistant professor in the University of Munich, has been made professor of inorganic chemistry in the Polytechnic Institute.

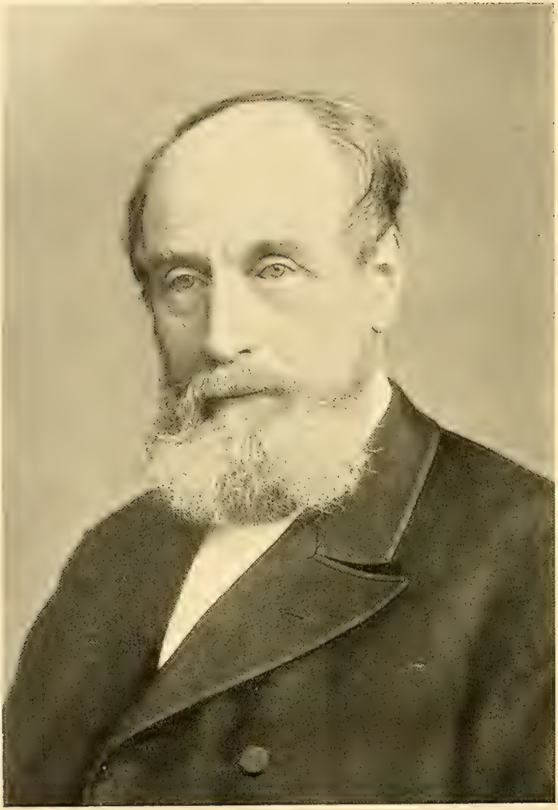
DR. OTTO V. FURTH has qualified as docent in physiology in the university at Vienna, and Dr. Peter Polis for meteorology, and Dr. Mat Semper for anatomy in the Polytechnic Institute at Aachen.

AT the recent meeting of the Association of Colleges and Preparatory Schools of the Middle States and Maryland, a resolution was presented by Dr. Nicholas Murray Butler, of Columbia University, and adopted, providing that the Association urge the early establishment of a joint college admission examination board, to be composed of representatives of colleges and preparatory schools in the Middle States and Maryland, and that the colleges be requested to coöperate in adopting a uniform standard of admission.

CLEVELAND ABBE, JR., Ph.D. (Johns Hopkins), and L. C. Glenn, Ph.D. (Johns Hopkins), are teaching physiography in South Carolina, the former at the Winthrop Normal and Industrial College, Rock Hill, S. C., and the latter at South Carolina College, Columbia, S. C. Dr. Abbe also conducted a very successful class at Rock Hill in the summer of 1899. As a result of the support given to the subject and through the efforts of the instructors, a popular interest has been aroused that is most promising. It is hoped that continued effort may bring about a great betterment in geography teaching of all grades in the State.

IT will be remembered that the philosophical faculty of the University of Berlin refused to take action against Dr. Arons, docent for physics, who had been charged with taking part in socialist agitation. The minister of education thereupon appealed to the Court of second instance, presided over by the under-secretary of his own department and this Court now recommends that Dr. Arons should be deprived of his right to deliver lectures.

AN election to an Isaac Newton studentship at Cambridge University will be held in the Lent term, 1900. The studentship is of the annual value of £200 and is tenable for three years. It is open to members of the university under the age of 25 years on January 1, 1900, who have been admitted to the degree of B.A. It will be the duty of the student to devote himself during the tenure of the studentship to study or research in some branch of astronomy or of physical optics, according to a course proposed by himself and approved by the electors. Candidates must send in their applications with certificate of birth to the Vice-Chancellor between the 16th and 26th days of January next, together with testimonials and such other evidences as to their qualifications and their proposed course of study or research as they may think fit. Candidates are recommended to send with their applications an account of any work bearing on astronomy or physical optics on which they may have been engaged and to forward copies of any papers they may have published on those subjects. They should also furnish the electors with a clear statement of the course of study or research which they propose to pursue during the tenure of the studentship.



SIR WILLIAM DAWSON.

SCIENCE

FRIDAY, DECEMBER 22, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SIR WILLIAM DAWSON.

IN Sir William Dawson there has passed away the last survivor of that distinguished group of naturalists which in the earlier part of this century achieved for science in America such brilliant results and such widespread recognition—men whose range of knowledge was almost encyclopædic and many of whom made valuable contributions to science, in widely separated fields. The environment of the man of science has now changed and the older type of naturalist seems unfortunately about to disappear.

Sir John William Dawson was a native of Nova Scotia, a province which has produced more than its share of the Canadians who have risen to eminence in the various walks of life, having been born at Pictou on October 13, 1820. He died at Montreal on November 19, 1899, at the age of 79.

His father, James Dawson, was a native of Aberdeen Scotland, and came to Nova Scotia to fill a position in a leading business house in Pictou, and on the termination of his engagement began business there on his own account.

While still at school in Pictou at the age of 12 he developed a love for natural science, inherited from his father, and made large collections of fossil plants from the Nova Scotia coal measures, so well exposed about his native place. He speaks of himself at that time as being a "moderately diligent but not a specially brilliant

pupil." On leaving school he studied at Pictou College and subsequently at the University of Edinburgh. While at the former seat of learning, at the age of 16, he read before the local Natural History Society his first paper, having the somewhat ambitious title 'On the Structure and History of the Earth.' He returned to Nova Scotia in 1847 and two years later went to Halifax to give a course of lectures on Natural History subjects in connection with Dalhousie College, and organized classes for practical work in mineralogy and paleontology. These were attended by students, citizens and pupils of higher schools, a foreshadowing of university extension. In 1850, at the age of 30, having already attracted some attention by the publication of a number of papers, reports and lectures, he was appointed Superintendent of Education for Nova Scotia. From this time he became known in his native province as an indefatigable promoter of educational progress and a founder of educational institutions. His work in connection with this position obliged him to travel continually through all parts of the Province and on these journeys he accumulated that immense mass of information concerning the geology and mineral resources of Nova Scotia which are incorporated in his largest work—that entitled Acadian Geology.

Sir Charles Lyell, in 1841, on his first visit to America, met Sir William and was by him conducted to many places of geological interest in Nova Scotia, and on his subsequent visit in 1852, they together continued their studies in Nova Scotian Geology. In a letter to Leonard Horner, dated September 12th of this year, Lyell writes:

"My companion, J. W. Dawson, is continually referring to the curious botanical points respecting calamites, endogenites and other coal plants, on which light is thrown by certain specimens collected by him at Pictou. He told me that the root of the pond lily, *Nymphœa odorata* most resembled Stigmaria in the regularity of its growth, and Dr. Robb showed me a dried specimen, a rhizoma, which being of a totally different family and therefore not strictly like, still suggests the probability of the Stigmaria having grown in slush in like manner." And in another part of the same letter he, referring to the now celebrated Joggings Section on the coast of Nova Scotia, says: "Dawson and I set to work and measured foot by foot many hundred yards of the cliffs, where forests of erect trees and calamites most abound. It was hard work as the wind one day was stormy and we had to look sharp lest the rocking of living trees just ready to fall from the top of the undermined cliff should cause some of the old fossil ones to come down upon us by the run. But I never enjoyed the reading of a marvellous chapter of the big volume more. We missed a botanical aide-de-camp much when we came to the top and bottoms of calamites and all sorts of strange pranks which some of the compressed trees played."

About this time the governing body of McGill College, at Montreal, were looking about for some one fitted to assume the Principalship of the institution and to reorganize it.

The College, founded by Royal Charter in 1821, had made but slow progress in its earlier years and was at this time, through litigation and other causes, almost in a state of collapse. Sir William—then Mr. Dawson—was pointed out to the Governors of the College by Sir Edmund Head, then Governor-General, of Canada, as a man who if his services could be secured was eminently fitted to undertake the task of reconstructing the University. In the meantime, ignorant of all this, he was prosecuting a candidature for the chair of Natural History in his Alma Mater, the University

of Edinburgh, rendered vacant by the death of Professor Edward Forbes, and in which he was strongly supported by the leading geologists of the time. By a strange coincidence, just as he was about to leave Halifax for England, in connection with this candidature, intelligence arrived that the Edinburgh chair had been filled at an earlier date than his friends had anticipated, and at the same time a letter was received offering him the Principalship of McGill.

The services of Dr. Dawson were accordingly secured and in 1855 he assumed the Principalship of McGill College, stipulating at the same time that the chair of Natural History should be assigned to him. In his Inaugural Discourse he said: "At a time when literary and scientific pursuits are so widely ramified every one who aims to do anything well must have his special field of activity. Mine has been the study of nature, especially in these bygone aspects which it is the province of geology to investigate. My only other special qualification for my present position depends on the circumstance that the wants of my native province have induced me to devote much time to inquiries and pursuits relating to popular education. I come to you, therefore, as a naturalist and an educationalist, trusting that I may be enabled in these capacities to render myself useful, and asking for my youth and present inexperience in the affairs of this Institution your kind indulgence, and for the work in which I shall be engaged your zealous cooperation."

The University as he found it had three faculties and but sixteen professors, a number of whom gave only a portion of their time to university work, while the buildings and equipment were wretched. When it is stated that the University has now one hundred and twenty professors and instructors of various grades, and an equipment which is in all departments fairly good and in some of them unsurpassed, some idea may be gained of the progress which the institution made under Sir William Dawson's care and guidance.

As Professor of Natural Science, Sir William at this time delivered courses in Chemistry, Botany, Zoology and Geology. Natural Science became a very favorite study among the students, for he was an excellent lecturer, and his enthusiasm for these studies was communicated to all who heard him. As years went on the instruction in the first three of these subjects was undertaken by others, and a special chair of Geology and Paleontology was endowed by his old friend and co-worker, Sir William Logan; a chair which he held until his final retirement. His teaching work, however, formed but a small part of his daily labors. In addition to administering the affairs of the University he was first and foremost in every movement to further education in the province and no educational board was complete without him. He was the Honorary President of the Natural History Society and never missed a meeting or a field day, and also identified himself closely with many other societies in Montreal and spared neither time nor labor on their behalf.

Over and above all this he found time to carry out original work along several lines, achieving most valuable results—as well as to write many popular works on science more especially in its relation to religion. Original investigation he always considered to be one of the chief duties and pleasures of a man of science. Most of his work along these lines was done during his summer vacations, in fact he was led to accept the position of Principal in McGill, chiefly by the fact that the vacations gave him leisure and opportunity for work of this kind.

He was always very progressive in his ideas relative to the scope and development

of university teaching, and was continually urging the endowment of new chairs and the broadening of university work, so that all young men wishing to train themselves for the higher walks of life might in the university find their needs supplied. As an instance of this it may be mentioned that so far back as 1858 he succeeded in establishing a school of Civil Engineering, which after a severe struggle for five years succumbed to some unfriendly legislation, only however to be revived by him in 1871 and developed into the present Faculty of Applied Science of McGill University, with its numerous departments, its full staff of instructors and excellent equipment. Sir William, furthermore, never hesitated if funds were not forthcoming in sufficient amount for these purposes to subscribe large sums out of his own limited private means, and he was also the continual helper of needy students desiring to avail themselves of the university's teaching.

Sir William received the degree of M.A., from the University of Edinburgh, in 1856, and the degree of LL.D., from the same University in 1884. His attainments and the value of his contributions to science were widely recognized and he was elected an honorary or corresponding member of many learned societies on both sides of the Atlantic. He was made a Fellow of the Geological Society of London, in 1854 and of the Royal Society in 1862. He was the first President of the Royal Society of Canada and has occupied the same position in the Geological Society of America and in both the American and British Associations for the Advancement of Science. He was made a C. M. G., in 1883 and a Knight Bachelor in the following year.

After a long life of continuous labor, Sir William's health in 1892 became seriously impaired and it became necessary for him to lay aside his work for a time and go abroad. Failing to recover his strength, however, he resigned his position as Principal in June, 1893, and retired from active work. During the later years of his life his strength gradually ebbed away and what little work he could undertake consisted in arranging his collections and working up some unfinished papers. Several of these were published in 1894 and 1895, but the years of quiet labor in his favorite pursuits to which he looked forward at this time were cut short by a series of sharp attacks culminating in partial paralysis, which forbade further effort. During the last few years from time to time his strength rallied somewhat and he attempted to resume his work. Only a few days before his death he penned a short essay on the Gold of Ophir. He passed away on the 19th of last month, very peacefully and without pain. We may say, in the words of Dr. Peterson, his successor in the Principalship of the University. "For such a painless passing out of life no note of sorrow need be struck. There is no sting in a death like his, the grave is not his conquerer. Rather has death been swallowed up in victory—the victory of a full and complete life, marked by earnest endeavour, untiring industry, continuous devotion and self-sacrifice, together with an abiding and ever-present sense of dependence on the will of Heaven. His work was done, to quote the great Puritan's noble line, 'as ever in his great Taskmaster's eye.'"

He leaves a widow and five children, of whom the eldest, Dr. George M. Dawson, the present Director of the Geological Survey of Canada, has inherited his father's taste for geological studies and has achieved wide distinction in the world of science.

Sir William's first original contribution to science was a paper read before the Wernerian Society of Edinburgh in 1841, on a species of field mouse found in Nova Scotia. From that time onward he was a

continuous contributor to scientific journals and to the publications of various learned societies. His papers were very numerous and covered a wide range of subjects in the domain of Natural History. The most important work of his earlier years was an extended study of the geology of the eastern Maritime Provinces of the Dominion of Canada. His results are embodied in his Acadian Geology, already mentioned, a volume of nearly 1,000 pages, accompanied by a colored geological map of Nova Scotia, which has passed through four editions. In writing to Sir William in 1868, Sir Charles Lyell says of this work, "I have been reading it steadily and with increased pleasure and profit. It is so full of original observation and sound theoretical views that it must, I think, make its way and will certainly be highly prized by the more advanced scientific readers." It is the most complete account which we have of the geology of Nova Scotia, New Brunswick and Prince Edward's Island, although since it appeared large portions of these provinces have been mapped in detail by the Geological Survey of Canada and Sir William's conclusions modified in some particulars. In carrying out this work Sir William paid especial attention to the Paleontology of the Carboniferous system and to the whole question of the nature and mode of accumulation of coal. He subsequently studied the paleontology of the Devonian and Upper Silurian Systems of Canada, discovering many new and important forms of plant life. In 1884 he began the study of the Cretaceous and Tertiary fossil plants of Western Canada and published the first of a series of papers on the successive floras from the Lower Cretaceous onwards, which appeared in the Transactions of the Royal Society of Canada. He also contributed a volume entitled The Geological History of Plants to Appleton's International Scientific Series. In 1863 he published his Air Breathers of the Coal Period, in which were collected the results of many years' study in the fossil batrachians and the land animals of the coal measures of Nova Scotia. The earliest known remains of microsauria were then discovered by him in the interior of decayed tree stumps in the coal measures of South Joggings. The results of his later studies on these creatures were embodied in a series of subsequent papers which appeared from time to time.

On taking up his residence in Montreal his attention was attracted to the remarkable development of the Pleistocene deposits exposed in the vicinity of the city and he undertook a detailed study of them, and especially of the remarkably rich fossil fauna which they contain. He also studied subsequently the Pleistocene deposits of the Lower St. Lawrence and instituted comparisons between them and the present fauna of the Gulf of St. Lawrence and of the Labrador coast. The results of these studies appeared in a series of papers as the work progressed and were finally embodied in a volume entitled The Canadian Ice Age, which was issued in 1893, as one of the publications of the Peter Redpath Museum of McGill University. This is one of the most important contributions to the paleontology of the pleistocene which has hitherto appeared.

Sir William's name is also associated with the renowned Eozoon Canadense, discovered by the Geological Survey of Canada in the Grenville limestones of the Canadian Laurentian and described by him in 1864 as a gigantic foraminifer. Concerning this remarkable object there has been a widespread controversy and a great divergence of opinion. Some of the most experienced observers in the lower forms of life, such as Carpenter, accepted it as of organic origin, while others considered it to be inorganic. And while the balance of opinion now possibly favors the latter view, its resemblance

microscopically to certain organic forms is certainly most remarkable. The literature of this subject, which includes many papers by Sir William, is quite voluminous, but the chief facts are summed up in his book entitled The Dawn of Life, which appeared in 1875.

Sir William was also a prolific writer of popular works on various geological topics. Among these may be mentioned his Story of the Earth and Man, his Fossil Men and their Modern Representatives, his Meeting Place of Geology and History, and his Modern Science in Bible Lands. These books, all written in a very entertaining style, had a wide circle of readers and many of them passed through several editions.

Other volumes from his pen, as well as many papers contributed to various religious publications, treated of the relation of science and religion. One of the earliest of these was entitled Archaia, and dealt with the relations of historical geology to the Mosaic account of the Creation. In others he considered the relation of the evolutionary hypothesis to religious thought. He was always, but especially in his earlier years, a strong opponent of the Theory of Evolution and vigorously combated it. Being above all things deeply religious and considering the evolutionary explanation of the origin of the universe to be contrary to the teachings of Scripture, he refused to accept it. This was, after all, but the weakness of a strong man. It did not, however, tend to enhance his reputation among men of science, who are commonly willing to let truth work out its own results, knowing that apparent contradictions are merely indications that the whole truth has not been discovered.

These works on the relation of science and religion met a popular need and were of great comfort to many a pious soul who feared that the whole framework of faith was being swept away by the advancement of science. Their value, however, was not permanent and they are not the works by which Sir William Dawson will be remembered. His reputation is founded on the great contributions to our permanent stock of knowledge which he has made and which are embodied in his works on pure science, representing achievements of which any man might well be proud.

Sir William had a courteous, or rather a courtly manner, based on a genuine consideration for all. He was respected and beloved by all who knew him and especially endeared himself to all who studied under him. The preëminent note of his character was simplicity and singleness of purpose. His loss will be felt especially in the institution with which he was long connected, but his name has been perpetuated in connection with the geological department of his University by the establishment of a second chair in geology, to be known as the Dawson Chair, which has just been endowed in his memory by one of the great benefactors of the University, Sir William Macdonald.

FRANK D. ADAMS.

McGILL UNIVERSITY,
December 8, 1899.

EXTENT OF INSTRUCTION IN ANTHROPOLOGY IN EUROPE AND THE UNITED STATES.

REGULARLY authorized instruction in anthropology dates from the second half of the present century. Before passing the threshold of the next, it might be well to have the benefit of any inspiration which may be drawn from the progress of this new science as a branch of university discipline.

The time, the closing of a century, for such a review is, of itself, opportune. Even if it were not so, occasion would not be wanting in the independent movement in different countries looking toward the establishment of chairs and lectureships of anthro-

pology. Professor W J McGee's efforts along that line in this country are noteworthy. Professor Wilhelm Waldeyer in his inaugural address about a year ago as Rector of the University of Berlin strongly emphasized the desirability of instituting chairs of anthropology in the universities of the German Empire.*

The Anthropological Section of the British Association for the Advancement of Science at the Bristol meeting, September, 1898, appointed a Committee to ascertain "The present state of anthropological teaching in the United Kingdom and elsewhere." Professor E. B. Taylor was made Chairman of this Committee, and Mr. H. Ling Roth, Secretary. Funds were voted for carrying on the investigation. The results of this Committee's work are, no doubt, forthcoming in the report of the Dover Meeting of the British Association which was to be held in September, 1899.

The substance of this article was presented by the writer before the Anthropological Section of the American Association for the Advancement of Science, at Columbus, August, 1899, and led to the appointing of a committee to consider ways and means of furthering the instruction in anthropology in our own institutions of learning, and to report at the Christmas meeting. The committee appointed by the Chair are W J McGee of Washington, Frank Russell of Cambridge, and George Grant MacCurdy of New Haven.

To go back half a century, Professor Serres held the Chair of Anatomy at the Natural History Museum of Paris when it became the Chair of Natural History of Man, or *Anthropology*, as Serres himself called it in announcing his course.

In 1867, Paul Broca opened a laboratory of anthropology in connection with the *Société d'Anthropologie de Paris*, then already eight years old. This laboratory became part of the *École pratique des Hautes Études* the next year (1868). As early as 1870, Broca had already established a regular course of lessons which was kept up until 1876, when it was merged in the newly-founded *École d'Anthropologie de Paris.* The latter was the first and remains the only school of its kind in the world.

Across the Channel, Sir William Flower had this to say in 1881: "In not a single university or public institution throughout the three kingdoms is there any kind of systematic teaching, either of physical or of any other branch of anthropology, except so far as comparative philology may be considered as bearing upon the subject."* In 1894 Sir William Flower could still say: "A professorship of Anthropology does not exist at present in the British Isles."† Instruction in some branches of anthropology was already being given, however, both at Oxford and Cambridge.

At Oxford, E. B. Tylor was made University Professor and Reader of Anthropology, December 31, 1898. Professor Tylor is also keeper of the University Museum. As he was the first Instructor in Anthropology (since 1883) in the British Isles, so is he the first Professor and the only one. Arthur Thomson, University Professor of Human Anatomy, gives instruction in physical anthropology, and Mr. Henry Balfour, Cur. Pitt-Rivers Museum, lectures on: 'Arts of Mankind and their Evolution.'

At Cambridge, Dr. Haddon, F.R.S., and Mr. W. H. L. Duckworth have, for some time, been recognized teachers of anthropology, and a lecturer on the subject has

* Ueber Aufgaben und Stellung unserer Universitäten seit der Neugründung des deutschen Reiches. Berlin, 1898. Druck von W. Büxenstein.

* Presidential address to the Department of Anthropology, British Association, for the Advancement of Science (York meeting).

† Presidential address to the Section of Anthropology, B. A. A. S. (Oxford meeting).

just been appointed. Alexander Macalister, Professor of Human Anatomy, has, for a number of years, found time to give instruction in physical anthropology.

Sir William Turner of Edinburgh (Professor of Human Anatomy) delivers a special course of lectures, with practical demonstrations, in physical anthropology. A Museum of Anthropology was recently established at the University of Aberdeen; so that instruction in anthropology may, in all probability, be given there.

In Ireland, Dr. C. R. Browne of Trinity College, Dublin, gives demonstrations in anthropometric methods. In addition to the work done in the Anthropometric Laboratory, every year, the instruments are taken to some selected district in Ireland and a systematic study of the inhabitants is made. The Royal Irish Academy makes yearly grants to the committee in charge of this work, the character of which may be ascertained from Dr. Browne's recent report on 'The Ethnography of Clare Island and Inishturk, Co., Mayo.'*

Germany has but one professorship of anthropology — that at Munich held by Johannes Ranke. To quote Professor Wilhelm Waldeyer who speaks especially for Munich and Berlin:

"Nur in München ist ein Professor ordin. für Anthropologie angestellt; derselbe hat auch ein besonderes Institut und einen Assistenten, Hrn. *Dr. Birkner.* Sie wissen, dass *Johannes Ranke* der Professor ordin. ist.

"An den übrigen deutschen Universitäten werden zwar anthropologische Vorlesungen gehalten, aber wohl nur von Professores extraordinarii und Privat Docenten, ohne besonderen Lehrauftrag seitens der Regierung, rein als Privatsache, und es bestehen keine Institute für Anthropologie.

"Hier in Berlin lesen seit einigen Jahren:

"(1) Dr. *von Luschan*, Titular professor, über physiche Anthropologie und über Ethnologie; ferner gibt er im Völkermuseum (ganz unabhängig von der Universität), anthropologische und ethnographische Uebungskurse. (2) Professor Dr. *Wilhelm Krause*, Laboratoriumsvorstand and der anatomischen Anstalt, liest über 'Rassenkunde' und gibt Uebungen in 'anthropologischer Messungskunde.' (3) Dr. *Seler*, Geschichte und Alterthumskunde Mexico's. (4) Dr. *Huth*, Geschichte und Völkerkunde Siberiens.

"Wie es an den andern Universitäten ist, weiss ich nicht, abgesehen von dem, was ich vorhin gesagt habe."

Professor Ludwig, of Bonn, who occupies the Chair of Zoology and Comparative Anatomy, gives, in addition, a course in Physical Anthropology. Emil Schmidt (Prof. ordin. hon.) of the University of Leipzig, offers 'Anthropologie und Ethnologie' together with 'Anthropologische Uebungen.'

At Marburg i.H., P. Kretschner (Professor extraordin.) lectures on 'Indogermanische Völkerkunde und Urgeschichte Europas'; at Halle, Professor Kirchhoff, offers, among other courses, one in 'Anthropogeographie'; and at the Stuttgart Königl. Technische Hochschule, Professor Karl Benjamin Klunzinger gives instruction in anthropology and hygiene, in addition to zoology.

No French university offers a course in anthropology with the possible exception of Lyons where Ernest Chantre is Professor of Ethnology. This seems strange when we remember that the land of Buffon, Broca, de Quatrefages, and de Mortillet is looked upon as a pioneer in the anthropological sciences, and has trained a majority of all who are now teaching the subject. Channels of instruction have been found other than the universities—namely, the *École libre d'Anthropologie de Paris* and the *Museum d'Histoire Naturelle* at the *Jardin des Plantes.*

*Proc. Roy. Irish Acad. 3d ser., Vol. V., No. 1, Dec., 1898.

The École d'Anthropologie offers nine courses by as many professors. They are as follows:

Matthias Duval; *Anthropogénie, Embryologie.*

André Lefèvre; *Ethnographie et Linguistique.*

Letourneau; *Sociologie*

Hervé; *Ethnologie.*

Manouvrier; *Anthropologie physiologique.*

Capitan; *Anthropologie préhistorique.*

Laborde; *Anthropoligie biologique.*

Mahoudeau; *Anthropologie zoologique.*

Schrader; *Géographie anthropologique.*

A monthly *Revue* is published by the professors. The Laboratory of Anthropology which forms a part of the system called *École pratique des Hautes Études en Sorbonne* very naturally finds a home at the *École d'Anthropologie.*

The Chair of Anthropology at the *Museum d'Hist. Naturelle* is occupied by Prof. Hamy. His colleague is Dr. Verneau, who also offers courses in anthropology at the *École Coloniale* and the *Hôtel de Ville.*

The Universities of Italy make a good showing. Giuseppe Sergi is Professor of Anthropology at Rome, and Director of the Anthropological Cabinet, and Giustiniano Nicolucci fills a similar position at Naples, where Drs. Penta and Zuccarelli are Docents for Criminal Anthropology. The *Regio Istituto di Studi Superiori Pratici e di Perfezionamento,* Florence, has the distinction of a professor of anthropology in *Paolo Mantegazza.* In three other Italian Universities, the subject is receiving attention. Professor Severi is the authorized Docent for Legal Anthropology at Genoa; Professor Lombroso, for Criminal Anthropology at Turin; and Tito Vignolo for Anthropology and Comparative Psychology at Milan.

Spain and Portugal have, each, one chair of anthropology—at Madrid and Coimbra, respectively. At Madrid, Manuel Antón y Ferrándiz is Professor *Cathedratico* of Anthropology and the Natural History of Man; at Coimbra, Bernardino Luis Machado Guimarães is Professor *Cathedratico* of Anthropology and Paleontology.

Dr. Rudolph Martin, sometime instructor in Anthropology at the University of Zurich, Switzerland, has just been promoted to an assistant professorship, Dr. Martin is also Docent for Anthropology in the Polytechnic School of Zurich.

Hungarian, German and Bohemian Universities all are contributors to anthropology in the Empire of Austria-Hungary:

Aurel Török, Professor ordin., Anthropology and Ethnology, and Director of the Anthropological Museum, Budapest; Lubor Niederle, Professor ordin., Anthropology and Prehistoric Archæology, Prague; and Moriz Hoernes, Professor extraordin., Prehistoric Archæology, Vienna. At the latter University, Dr. Michael Haberlandt is Docent in General Ethnography, and Dr. Phillip Paulitschke's lectures are ethnographical although his title is Docent in Geography.

A chair of geography and anthropology was recently created at the Imperial Academy of Sciences, St. Petersburg; D. N. Anutchin is the occupant. At the University, E. J. Petdri is Professor of Geography and Ethnography and Director of the University Geographical Anthropological Cabinet.

In Moscow, D. N. Anutchin is Professor of Geography and Ethnography and Director of the University Anthropological Museum; and Dr. N. N. Charuzin is Docent for Ethnography.

In Holland, there is no professorship of anthropology, so far as appears. J. J. M. de Groot is Professor of Ethnography at Leyden; Dr. G. J. Steinmetz is Instructor in Ethnology at Utrecht; and Professor G. Jelgersma of Amsterdam lectures on Criminal Anthropology.

Monsieur E. Houzé is Professor of Anthropology at the *Université libre de Bruxelles*, Belgium. The course given by Professor Houzé was inaugurated in 1884. At the new University, Brussels, Professor G. Delbastee gives lectures on Criminal Anthropology.

For Scandinavia, there is a chair of northern archæology at the University of Christiania occupied by Professor O. Rygh. In the same Faculty, Yngvar Nielsen is Professor of Geography and Ethnography and Director of the University Museum of Ethnography.

The University of Athens possesses an anthropological museum; Dr. K. Stephanos, the Curator, may possibly give some instruction in the subject.

Mention has already been made of the movement in the United States to give anthropology more general recognition as a branch of university discipline. It has already taken its place in the curriculum of a number of our leading institutions.

In the Peabody Museum of American Archæology and Ethnology at Cambridge, Harvard University has a most suitable habitation for a department of anthropology—extensive collections, laboratories, special library, lecture rooms, all combined under one roof and management, with its own special faculty, endowments, fellowships and scholarships. Frederick Ward Putnam, Curator of the Museum and Professor of American Archæology and Ethnology; Dr. Frank Russell, Instructor in Anthropology; and Roland B. Dixon, Assistant in Anthropology, offer a number of courses, both general and special. An anthropological club holding semi-monthly meetings testifies to the lively interest in the subject at Harvard.

Only a few months ago a professorship of anthropology was created in Columbia University, New York, and Dr. Franz Boas, for several years Lecturer in Anthropology, was promoted to the Chair. The work of Professor Boas is done in part at the American Museum of Natural History and in part at the Psychological Laboratory of the University, where Dr. Livingston Farrand (Instructor in Psychology) gives courses in ethnology, one of them being half of a general introductory course in anthropology by Drs. Boas and Farrand.

At the University of Chicago, there is a provisional union of sociology and anthropology in a single department. "The differentiation of an independent department of anthropology and ethnology is anticipated." Dr. Frederick Starr is Associate Professor of Anthropology and Curator of the Anthropological Section of Walker Museum.

At New Haven, Yale University has for several years had the benefit of a course in general anthropology based on Ranke's 'Der Mensch.' For this course we are indebted to William G. Sumner, Professor of Political and Social Science. Professor Sumner's generous impulses and admirable fitness, equal to his sense of the University's need, has led him to assume, willingly, extra labor and responsibility. To such men, many a university has been indebted for the growth and present richness of its curriculum, and, many a new science, for its separate and vital existence.

Dr. E. Hershey Sneath, Professor of Philosophy, gives a course entitled 'Philosophical Anthropology,' based on Lotze's Microcosmus.

The appointment of George Grant MacCurdy as Instructor in Prehistoric Anthropology at Yale dates from May, 1898. His courses are given at the University Museum, where a Laboratory of Physical Anthropology is being established, and where anthropological collections are being arranged both for students and for the public.

At Clark University, Worcester, A. F. Chamberlain is Lecturer in Anthropology. Assistant Professor W. Z. Ripley (Sociology

and Economics, Massachusetts Institute of Technology, Boston) gives a 'course of one term' in Anthropology at the Institute yearly; and at Columbia University (New York) in the School of Political Science, a course of one term entitled now Racial Demography, being a study of the population anthropologically of Europe and the United States. It was formerly called anthropology, but the title has been changed this year as given.

At the National Capital, some of the universities are making use of the anthropologists connected with the United States National Museum. Thomas Wilson, curator of the Division of Prehistoric Anthropology, lectures at the National University, and Otis T. Mason is lecturer in Anthropology at the Columbian University.

M. M. Curtis, professor of philosophy, Western Reserve University, Cleveland, gives a course of lectures on the history and the main problems and bearings of anthropology, and A. S. Packard, professor of Zoology and Geology, performs a like service for Brown University, Providence. During the month of March, 1899, Professor W J McGee, Ethnologist in charge of the Bureau of American Ethnology, Washington, D. C., gave, at the State University of Iowa, a course of eleven lectures in general anthropology to large audiences. Such a beginning augurs well for the future growth and development of a recognized branch of instruction.

Instruction in anthropology at the Ohio State University may be said to have a beginning in the work being done by Mr. W. C. Mills, Curator of the Ohio Archæological-Historical Society.

In the death of Professor Daniel G. Brinton, both the University of Pennsylvania and the Philadelphia Academy of Natural Sciences have lost a valued teacher of the anthropological sciences. No one has yet been appointed to take his place.

In order to reduce the above information concerning extent of instruction in anthropology to a more compact form, use is made of the following table.

Of the forty-eight institutions in the thirteen countries giving a place to anthropology in their curricula, eleven are located in the United States; and of the total teaching force of seventy-four, our own country is credited with seventeen. But in the matter

COUNTRIES.	Institutions.	Professors.	Assistant Professors.	Instructors.	Total teaching force.	FACULTIES.
British Isles.	4	1	0	8	9	Natural Science.
Germany.	7	1	2	8	11	Philosophical.
France.	4	11	0	1	12	Philosophical or Faculté de Lettres.
Italy.	6	3	0	5	8	Philosophical; Nat. Sci.; Med.
Spain.	1	1	0	0	1	Science.
Portugal.	1	1	0	0	1	Philosophical.
Switzerland.	2	0	1	1	1	Natural Science.
Austria-Hungary.	3	2	1	1	4	Philosophical.
Russia.	3	1	0	3	3	Natural Science.
Holland.	3	0	0	3	3	Various.
Belgium.	2	1	0	1	2	Medical.
Scandinavia.	1	0	0	2	2	Philosophical.
United States.	11	1	1	15	17	Various.
	48	23	5	48	74	

of professorships, the United States suffers by comparison, being allowed only one out of twenty-three by the strict terms of the title—that at Columbia held by Dr. Boas.

The above table is intended to serve more as a comparison of figures than of forces. To know precisely what is being done for the science in the several countries, one would have to take account of anthropological publications, museums, societies and clubs, as well as of sections of general scientific associations and academies of sciences. Such a compilation is beyond the scope of the present article.

So much for the extent * of instruction in anthropology as the century closes. The importance of the subject as a branch of university discipline, its terminology and the faculty to which it should belong, have all been touched upon by such authorities as Daniel G. Brinton † of Philadelphia, Friedrich Müller ‡ of Vienna, Rudolph Martin § of Zurich, and Geo. A. Dorsey || of Chicago.

Professor Brinton made a "brief presentation of the claims of anthropology for a recognized place in institutions of the higher education in the United States" and asked for "the creation in the United States of the opportunity of studying this highest of the sciences in a manner befitting its importance." His classification and nomenclature, and his general scheme for instruction in this science acted as a stimulus to discussion on two continents.

Brinton's principal subdivisions are:

I. Somatology—Physical and Experimental Anthropology.

II. Ethnology—Historic and Analytic Anthropology.

III. Ethnography—Geographic and Descriptive Anthropology.

IV. Archæology—Prehistoric and Reconstructive Anthropology.

Professor Müller does not see the need of separating the Geographical Ethnos from the Historic Ethnos, and, therefore, makes three divisions with a professorship for each:

I. Physical Anthropology.

II. Ethnography and Ethnology.

III. Prehistoric Anthropology. The first he would place with the medical faculty, the other two, with the so-called philosophical faculty of the German universities. When the three professors cannot be had—an anatomist for somatology, an ethnologist and linguist for ethnology and ethnography, and a geologist and archæologist for the prehistoric—then Müller would suggest a double division: (1) Physical and Prehistoric Anthropology and (2) Ethnology and Linguistics. This, however, would divide the professorship of Physical and Prehistoric anthropology between two faculties, giving half to the medical faculty and half to the philosophical.

Professor Martin, on the other hand, argues that "die ganze Anthropologie in der naturwissenschaftlichen Abteilung der philosophischen Fakultät ihren natürlichen Platz hat." This seems to be the more logical arrangement and the one adopted practically by every university professing to give instruction in the subject as shown in the table above.

* Corrections of and additions to the record are respectfully solicited. The writer is especially indebted to Monsieur le Ministre de l'Instruction publique et des Beaux-Arts, France; and Professors Wilhelm Waldeyer, Rector of the University of Berlin; Alexander Macalister, Cambridge, England; E. Houzé, Brussels; Moriz Hoernes, Vienna; W J McGee, Washington, D. C.; W. Z. Ripley, Boston; the Hon. W. T. Harris, U. S. Commissioner of Education; and his Excellency the Royal Prussian Kultusminister.

† Anthropology as a Science and as a Branch of University Education, Phila., 1892.

‡ Die Vertretung der anthropologisch-ethnologischen Wissenschaften an unsern Universitäten, Globus, Bd. 66, S. 245, 1894.

§ Zur Frage von der Vertretung der Anthropologie an unsern Universitäten Globus, Bd. 66, S. 304, 1894.

|| The Study of Anthropology in American Colleges. Archæologist, Dec., 1894, Waterloo, Indiana.

The difficulties of placing anthropology with this faculty or that are themselves evidence of the fundamental character of the science. A branch of instruction that may be claimed by different faculties, and, at the same time, not adequately represented in any, might justly claim title to a faculty of its own.

Anthropology has matured late; has been waiting for the contributions other sciences in the course of their development were bound to make to her; waiting till the prehistoric perspective came to supplement the historic, permitting man to take the same dispassionate view of self as of the rest of nature, till remote lands told their story of human variation and culture stages, and till the teachings of embryology and comparative anatomy were better understood. The development and succession of the sciences may be likened to the development and succession of the fauna of which man forms a part. As man is last and highest in the geological succession, so the science of man is the last and highest branch of human knowledge. It is to be hoped that the overflow from the sciences contributing to anthropology may be properly conserved and so distributed as to find its way more generally to the channels of university instruction. Whether the channel chosen be an existing faculty or a new and separate one is not so important as the stream it has to carry; and there is reason that to believe that stream is gaining in volume constantly.

After the foregoing article was in type, there came from his Excellency the Royal Prussian *Kultusminister*, in answer to my request of May 16th last for information, a manuscript statement handed in to him, September 27, 1899, by Professor Wilhelm Waldeyer entitled "Bericht über das anthropologishe Unterrichtswesen in Deutschland." From this the writer is able to supplement his own lists for Germany as follows:

Breslau, Dr. Partsch (Prof. ordin., Geography), 'Völkerkunde Europas'; Göttingen, Dr. von Bürger (Prof. tit., Zoology), 'Ursprung und Vorzeit des Menschen'; Heidelberg, Dr. H. Klaatsch (Prof. extraord., Anatomy), 'Anthropologie'; Kiel, Dr. Krümmel (Prof. ordin., Geography), 'Ausgewählte Kapitel der Anthropo-geographie'; Königsberg, Dr. Bezzenberger (Prof. ordin., Comp. Philology), 'Urgeschichte Ostpreussens'; Strassburg, Dr. G. Schwalbe (Prof. ordin., Anatomy), 'Anthropologie'; Tübingen, Dr. von Sigwart (Prof. ordin., Philosophy), 'Philosophical Anthropology.'

This increases the number of German universities giving instruction in anthropology by seven, but does not augment the number of professorships.

Dr. W. H. L. Duckworth is the newly appointed University lecturer in physical anthropology at Cambridge.

GEORGE GRANT MACCURDY.
YALE UNIVERSITY,
NEW HAVEN.

ECONOMICS, POLITICS AND FINANCE OF VOTING MACHINES.

THE writer, as a member, from its organization, of the New York State Commission to inspect and authorize voting machines for the use of the cities and towns of the state, and as Chairman for some years, to date, of the Finance Committee of the City Council of Ithaca, has had occasion to study the very novel and most ingenious construction of voting machines and to seek to ascertain their value in economics and politics, and as a matter of finance; and it is possible that economists and students of politics and of finance may find the deductions from this exceptionally fortunate experience both interesting and important—interesting as a curious illustration of the

inventive genius of our people and as an irruption of that genius into an unexpected line of work, important in its bearings upon good politics and on economics, through a better insurance of the expression of the real judgment and intent of the people, as given at the polls.

The 'voting machine' is an apparatus consisting of a very simple arrangement of a very simple form of mechanical counter, in groups, in such manner that, when the voter moves a handle or presses a button over a certain name, opposite the designation of a certain office, on the front of the machine, the act moves that individual counter one notch, and one is added to the reading on that particular count. It is also so arranged that, if the voter desires to vote a whole, '*a straight*' ticket, the pulling down of a handle, or the pressing of a button at the limit of the line of names of candidates, moves the counters of every individual candidate on that ticket and one motion counts a party-vote. Further, it is, in all approved voting machines, possible to vote any 'split ticket' and it is made a matter of fundamental construction that no voter shall be able to vote more than once for any candidate or for any party. In other words: the machine is constructed so that each voter shall, by the simple acts described, be able to vote, within the law, precisely as he may choose, while it is impossible for him to do anything which the law forbids. He has absolute freedom to do right; he cannot possibly do a legal wrong. The ingenuity and simplicity of these machines and the positive certainty of their operation as desired within legal limits make them, as a class, extraordinarily interesting studies in mechanism.

In New York, as in, now, quite a number of other states, there are provisions of law permitting and regulating the use of these machines and they have now had so extended and so extensive a trial that it is possible to speak positively of them as, where of approval construction, an entire and singular success. In New York, no voting machine can be employed until it has been fully inspected, carefully studied and unqualifiedly approved, by the Voting Machine Commission; from whom a report must be secured, and filed in the office of the Secretary of State, to the effect that the machine is capable of registering six hundred voters in the election hours, accurately and efficiently, can be safely employed for that purpose, and that the Legislature of the State is justified in legalizing its use. Under these provisions of law, the cities of Buffalo, Rochester, Utica, Ithaca and other smaller places, have now used the machines in regular elections. In one or two places, older forms of machine, introduced before the commission for their inspection and endorsement was formed, have not proved satisfactory; but the later experiments have been entirely so, and Buffalo has 108, Rochester 73, and other places lesser numbers, all of which are reported to have proved a marvellous success.

One of these machines costs \$500, registers a maximum, under the law—there is no limit in construction—600 voters, at the rate of 5 to 15 seconds each voter, saves \$16 a year in cost of operating a precinct, \$40 to \$50 in election printing, and, by enabling a reduction to be made in the number of election precincts, saves about \$200 on each one abolished. In Ithaca, the reduction, if the law is followed precisely, will be not less than two nor more than four districts, out of ten; saving the city from twenty to forty per cent. *net* on the investment. The following were the conclusions reported by the Finance Committee to the City Council and the people of Ithaca:

"Summarizing our conclusions your Finance Committee would respectfully submit that

"(1) The voting machine is a simple, reliable, durable and convenient apparatus for its purpose.

"(2) The machine compels the deposit of a perfect and accurate ballot, of the form chosen by the voter.

"(3) It restricts the voter absolutely to the limits of the law and permits him freedom as absolute in voting within that limit.

"(4) Blank and defective ballots, the usual fault of ordinary methods of voting, are entirely done away with and no man loses his vote through defect of the system, or fault of his own, if he votes at all. The disfranchised voter becomes unknown.

"(5) Fraudulent voting is impossible as well as errors in voting.

"(6) The vote cast is registered, vote by vote, with absolute accuracy and certainty.

"(7) The result can be declared immediately upon the close of the polls, having been already completely counted.

"(8) The cost of the system is so much less than that of the old method that the machines usually pay for themselves in from three to seven years.

"The whole case may be summarized in a sentence: 'The machines retain all the virtues and exclude all the vices of the old methods of balloting.' Their use would be entirely justified, even though they involve a more costly, rather than a much less expensive system. Their adoption is looked upon by your committee as promoting good politics, good morals and good finance."

The possible ultimate result of the general introduction of these new methods of election upon the freedom of the ballot and the honesty and accuracy of the count, and upon the future politics and economics of the state and nation, no one can probably quite realize or predict; but that this insurance of a full vote and an honest one will tell for good government, and the purification of parties and their methods, no one can doubt. As the representative of the Patent Office said, in his testimony before the Committee of Congress regarding the proposed, and later-enacted, measure legalizing the voting machine in federal elections we cannot doubt that "It is the last and best contribution to the science of good government."

Judge Cooley said that, in his opinion such a method is a 'constitutional right' of every voter. The most surprising fact is, perhaps, that in the case above referred to, there was but one protest, in the city of Ithaca, out of over 2500 voters. Every inspector of election signed a certificate to the effect that the experiment was absolutely satisfactory, and the only objections heard were from one 'party-leader,' and the only adverse interests discovered were those affected by the abolition of ballot-printing, which is a much larger item of cost—at political prices—than is usually supposed. Each printed ballot costs from four to twenty cents, at the various elections, municipal, state and general.

R. H. THURSTON.

ITHACA, December, 1899.

A COMPLETE MOSASAUR SKELETON, OSSEOUS AND CARTILAGINOUS.*

IN the spring of 1898, Professor S. W. Williston's fine memoir upon the Kansas Mosasaurs seemed to cover the subject completely, summing up all the facts derived from the great Kansas University collection, as well as many of the results of the labors of Cuvier, Owen, Marsh, Cope, Dollo, Baur, and others. But it appears impossible to say the last word in paleontology. Professor Williston himself has recently described a portion of the nuchal fringe of *Platecarpus*, as well as the epidermal fin contours. The remarkable specimen which has recently been mounted in the Marine Reptile Corridor of the American Museum throws new and welcome light not only upon *Tylosaurus*, but upon the anatomy of the Mosasaurs in general.

Together with the practically complete bony skeleton, are seen cartilages of the throat and chest, portions of the larynx, trachea, bronchi, the epicoracoids, as well as the suprascapulæ, the sternum and sternal ribs. Originally these parts were preserved entire, and we must deeply re-

* Extract from Memoirs of the American Museum of Natural History, Vol. I., Part IV.

gret that before this specimen came into possession of the Museum, much damage was done to the relatively inconspicuous cartilages, in course of removal of the bones. Nevertheless Mr. Bourne, of Scott City, Kansas, who excavated the fossil, deserves great credit for the skill and care with which the conspicuous parts were removed.

The specimen reached the Museum in a series of large slabs of Kansas chalk and was worked out in such a manner that all the contours of the original slabs are preserved and fitted together by their edges, as in the original bedding; therefore the great lizard with all its parts, excepting a few minor pieces, lies exactly as it was imbedded. The original matrix surrounds practically all the bones, and can be distinguished from the buff-colored outlying plaster, by its somewhat darker shades. The whole is mounted upon a panel twenty-five feet long and permanently placed in a corridor which is to be devoted to marine reptiles.

The animal lies outstretched upon its ventral surface, so that all the bones are exposed upon the dorsal or lateral surfaces, excepting the left humerus and ulna, which are overturned. The skull is crushed to the left, together with the vertebræ, as far back as the 6th dorsal. From the 7th to the 10th dorsals the vertebræ are confused and displaced. The 11th dorsal to 29th caudal are horizontal with the transverse processes outspread and the spines crushed to the right and left. The remaining caudals, 30th–70th, lie upon the left side apparently in a natural position. The pelvis and hind paddles have evidently shifted backwards in settling, so that the mooted question of the position of the sacral vertebra cannot be positively settled by this specimen.

This specimen agrees very closely in size with Cope's cotype of *T.* (*Liodon*) *dyspelor*, founded in 1871 at Fort Wallace, Kansas, and described by him in the 'Cretaceous Vertebrata' (p. 167). The skull agrees exactly in size with the fine one mounted in the Munich Museum, described by Merriam (1894, Taf. II.) as *T. proriger*. Size is no criterion, or at best an uncertain criterion of a species, but Williston advances (1898, p. 175) no other satisfactory means of separating *T. dyspelor* from *T. proriger*. Thirty-five feet is the length assigned by this author to the largest Tylosaurs, a length considerably exceeding that of the present specimen. It is evident, however, that a

FIG. 1. Complete skeleton of *Tylosaurus dyspelor* in frame. $\frac{1}{54}$ nat. size.

young *T. dyspelor* might exhibit exactly the measurements of *T. proriger.*

According to Williston the tail terminates very abruptly in *Tylosaurus proriger*, in contrast with its gradual and slender termination in *Platecarpus.* If this was the case in this specimen of *T. dyspelor*, we should not allow more than 15 inches or 38 centimetres additional, giving us a total length of about 29 feet or 8.83 metres. The *proportions* of different regions of the body are very characteristic of different genera of Mosasaurs. In this individual the total of 29 feet or 9 metres is roughly distributed as follows:

	Feet.	Metres.
Head and jaw	4	1.22
Neck	2	.61
Back	8	2.44
Tail	15	4.56
Total	29	8.83

Thus the back is four times the length of the neck, twice the length of the head, and about one-half the length of the tail. In other words, the tail is longer than the other regions of the body combined. These proportions are carefully observed in Mr. Knight's restoration.

There are positively *seven cervicals*, the number assigned to all the American Mosasaurs by Williston, and this point is of considerable importance as bearing against the supposed Dolichosaurian affinities of the Mosasaurs. In this specimen there are certainly *twenty two dorsals*, while Williston assigns *twenty-three dorsals* to *Tylosaurus proriger*. Merriam assigns twenty-three dorsals to *Tylosaurus* (*op. cit.*, p. 15). Williston is undoubtedly correct in placing the pelvis upon the first non rib-bearing vertebra, which thus represents the *sacral.*

In this specimen, as in the living Monitor lizards, the 30th vertebra behind the head is distinguished by the absence of a rib, and by the sudden expansion of the diapophysis. This first expanded vertebra, as determined by Williston, must be considered the sacral, analogous with the most anterior of the *two* sacrals in *Varanus.* This vertebra is not perceptibly different in size from the pygals behind it. Unfortunately the tips of the diapophyses are not preserved, and there is no means of demonstrating positively that the ilium was attached by joint or ligament.

There are no lumbars. The number of pygals, or non chevron-bearing caudals, cannot be determined, because many chevrons are not exposed.

The vertebral formula is therefore as follows:

Cervicals	7
Dorsals, with sternal ribs	10
Dorsals, with floating ribs	12
Sacrals	1
Caudals and pygals	72 + (= 86).

A most interesting feature is the adaptive modification of the mid-caudal centra and spines, apparently for the support of a dorsal *caudal fin.* Dr. W. D. Matthew first directed the writer's attention to this structure.

Williston has figured the caudals of *T. proriger* as having spines of a nearly uniform height, while in *Clidastes velox* (*op. cit.*, p. 152) he describes an extension of the spines as probably designed to support a fin. This specimen of *T. dyspelor* shows as evidence of a fin:

1. A slight upward elongation of the spines in the mid-caudal region, beginning at C. 24 (in which the spine measures 10 centimetres) to C. 39–40 (in which the spine rises to 11 centimetres) and subsiding to 10 centimetres in C. 58. At the same time the spines change from a pointed and backwardly directed to a more square, upright, and truncated form. The vertical spine is upon C. 39; in front of this the spines of C. 1–38 lean backwards; while behind this the spines of C. 40–70 lean forwards, or are nearly upright. 2. There is some further evidence that the *upward*

curvature of the spine, is natural, and not due to post-mortem disturbance. This curve is beautifully indicated between C. 30 and C. 63; behind which the vertebræ dip down into the extremity of the tail. It is difficult to verify the existence of this curve in the living state by the measurement of the superior and inferior diameters of the centra. So far as measurements can be relied upon they tend to show that the vertebral centra were slightly longer above than below and thus produced the curve; the relations of the greatly reduced zygapophyses and the antero-posterior width of the spines also point to the same conclusion, for they show that if this column were straightened out the spines would come into contact. This condition is so unique, however, that it must be put forward with reserve.

The sharp ventral flexure or angulation of the tail of *Ichthyosaurus*, below the swelling of the caudal fin is not analogous to the very gradual upward curve in *Tylosaurus.*

We are now enabled to form a very clear idea of the general structure of the thorax, although certain details are still missing. All the true ribs are preserved on both sides, and, in spite of the havoc wrought in the removal of the chest region, we find all but one of the cartilaginous ribs on the left side and extensive portions of those on the right, as well as the central area of the sternum. The careful studies and drawings of this region by Dr. J. H. McGregor show clearly the relations of the actual and restored region, part of the preserved region being covered by the vertebræ and ribs.

The *cartilaginous ribs*, consist of broad bands which are closely concentrated and parallel as they converge towards the sides of the sternum, affording an exceedingly strong support for the thorax. The *floating* ribs decrease steadily in length and curvature. The coracoids do not unite in the median line as represented by Marsh, nor are they approximated as restored by Dollo in *Plioplatecarpus.* They are widely separated by epicoracoid cartilages having a united transverse diameter of about 22 centimetres. The inner ends of the bony coracoids are thus nearly nine inches apart. About one-half of the *sternum* is visible or preserved; as the cartilaginous ribs on the left side are nearly *in situ,* and those on the right approximately so, it is evident that the sternum had a triangular outline, thinning posteriorly for the junction of the 10th pair of cartilaginous ribs.

The sterno-coracoid plate thus corresponds closely with the Lacertilian type and bears a general resemblance to those of *Trachydosaurus*, *Varanus* and *Cyclodus*, as figured by Parker. There is no evidence of the presence of an episternum (interclavicle).

Behind the basioccipital is observed a supposed lateral cartilage of the larynx? *lx.* and its mate? *lx.* appears below just between the right pterygoid and quadrate. A bit of cartilage appears behind the left quadrate, another mass in front of the right quadrate, while the trachea extends from below the axis, is unfortunately destroyed as far back as the 5th rib, and diverges into the two bronchi just behind the coracoids. The tracheal rings are well exhibited.

The appendicular skeleton is remarkably well preserved. The *scapulæ* are fully exposed upon both sides, with the characteristic short and broad bony blades and the extensive crescentic cartilaginous suprascapulæ.

COMMON CHARACTERS OF FORE AND HIND PADDLES.

The metapodials and podials are somewhat displaced, but they enable us to make a reconstruction of the manus, aided by Williston's excellent photograph and outline of the paddle in *T. proriger.*

1. *Hyperphalangism* is a chief characteristic of the Tylosaur extremities. Williston's photograph shows 47 actual elements, to which 3 are added in his restoration of

T. proriger, making 50. Thirty-eight (38) elements are preserved in the left *fore paddle* or manus and 44 are inserted in our restoration, or 5 metacarpals and 39 phalanges. In the *hind paddle*, or pes, 33 metatarsals and phalanges are preserved on the left side (including an isolated phalanx which lies above the 50th caudal).

The phalangeal formula is *estimated* as follows:

		MANUS.	PES.
Digit	I.	5	5
	II.	8	8
	III.	8	8
	IV.	9	8
	V.	9	6
		T. dyspelor.	*T. dyspelor.*

It is apparent, so far as we can judge from this specimen, that in *T. dyspelor* the phalanges are less numerous than in *T. proriger*.

2. A second characteristic is the *marked broadening and shortening of the 5th metapodial* in both manus and pes, but especially in the pes. The carpus and still more the tarsus, on the postaxial (ulnar and fibular) sides are abbreviated. The result is that the 5th digit is drawn towards the body; its elements and joints alternate with those in the I.–IV. digits; as a whole it is set wide apart. Williston has recently shown that the epidermal fin web conforms in its contours to this peculiarity.

3. A third characteristic is the *alternation of the joints in the 1st and 5th digits* with those in digits 2, 3, 4. The pes further agrees with the manus in the expansion of the proximal part of metapodial I., and the shortening or drawing up of the first finger, whereby the middle points of the phalanges of Digit I. come opposite the joints of the phalanges in Digits II., III., IV., thus greatly strengthening the paddle as a whole. A similar adaptation by alternation of the phalangeal joints is observed in some of the Plesiosaurs, in which it is carried to an extreme, for the phalanges of all the digits alternate.

This specimen affords an exceptionally favorable opportunity for a restoration of the skeleton. This interesting work has been accomplished by coöperation. Dr. W. D. Matthew kindly undertook a natural-size drawing of the entire animal, succeeding especially in rearranging the vertebral column and skull. Mr. Horsfall completed the details of the skull by careful measurement and comparison with the drawings of Merriam and Williston. Dr. McGregor and the writer restored the paddles and the sternum.

The drawing is upon a one-eighth scale. There was probably a small rib upon the third and fourth cervicals which has not been indicated. The cervical intercentra are restored from a fine specimen of *Platecarpus*.

One of the most important features of the restoration sprang from the discovery that the cartilaginous ribs of the left side are practically in their normal relations. This fact enabled us to locate definitely the lower end of the ten true ribs, the sternum, the epicoracoids, and at the same time fix the position of the fore paddle with reference to the skull.

As above noted, the ribs were found to resemble those of *Sphenodon* much more closely than those of *Varanus*. They are thus given in the restoration the angle, position, and foreshortening characteristic of *Sphenodon*, as the narrow anterior part of the chest expands into the broader walls of the abdomen. The ribs in the plate are perhaps a shade too heavy.

The upward curvature of the tail is designed exactly as the vertebræ lie in the specimen, for the reasons already discussed.

RESTORATION OF THE ANIMAL.

In the restoration of the animal, Mr. Charles Knight has taken advantage of all the information afforded by Professor Williston's collections and descriptions, and of our detailed study of this fine specimen.

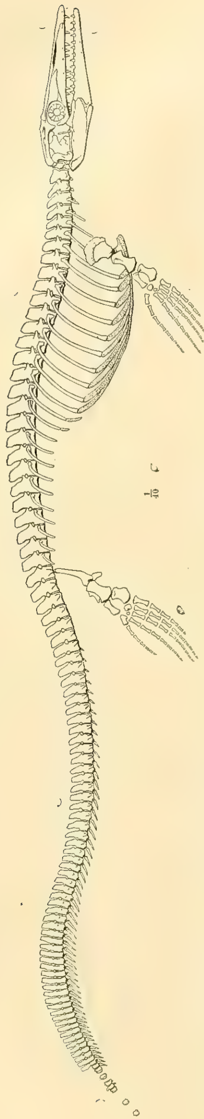


Fig. 2. Reconstruction of the Ram-nosed Tylosaur, after drawings, by W. D. Matthew and Bruce Horsfall, under direction of the author. $\frac{1}{40}$ nat. size.

Fig. 3. Restoration, by Charles Knight.

The animal was first carefully modelled upon a one-ninth scale.

Tylosaurus was a very powerful sea swimmer, propelled chiefly by the lateral motions of the body and tail. The caudal fin was a broad expansion along the dorsal line. The proportions can be precisely determined. The fore and hind paddles were similar in action and played a subsidiary part in guiding the animal, but were effective in the less rapid motions of the body. The indentation of the paddle border between the 4th and 5th fingers is upon Williston's authority. The nuchal fringe is also from this author's recent description of *Platecarpus*. The epidermal scaly covering is from Chancellor Snow's account of the *Tylosaurus proriger* covering. The expression of the top of the skull resembles that of *Varanus*, but in other points there is a wide departure from the Varanoid type.

The facts derived from this skeleton do not strengthen Baur's extreme opinion as to the intimate connection of this type with the Varanidæ. Besides the secondary degenerate adaptation to marine life shown in the girdles and appendicular skeleton, there are certain fundamental differences in the basioccipitals and ribs, in fact in all parts of the skeleton. These differences fully balance or overweigh the likenesses, which have long been dwelt upon by Cuvier, Owen and Baur, between the Mosasaurs and Varanoids, and do not even justify the assertion that the Varanidæ and Mosasaurs sprang from a common stem. The Mosasaurs are a very ancient marine offshoot of the Lacertilia, retaining certain primitive and generalized Lacertilian characters and presenting a few resemblances in the skull to the Varanoids; they are very highly specialized throughout for marine predaceous life, and constitute a distinct subdivision of the order Lacertilia.

HENRY F. OSBORN.

COLUMBIA UNIVERSITY.

THE INDIANA UNIVERSITY BIOLOGICAL STATION.

THE advantages of biological stations for purposes of research and instruction have had many advocates in recent years.

"There can be little doubt" says Parker, "that the study of zoology is most profitably as well as most pleasantly begun in the field and by the seashore, in the zoological garden and the aquarium." "The establishment of biological stations has done more to advance the study of zoology than any other one thing in this generation," says Conklin. "Certain desiderata are evident," adds Kofoid, "more biological stations, so that the conclusions arrived at in one locality may be extended and corrected in a score of others; and finally some biological Froebel, who shall demonstrate the disciplinary and cultural value of ecology as a field of biological instruction and establish a standard for others to imitate. In their work we may look for the happy combination of the sympathetic observation of the old-time naturalist, the technical skill and searching logic of the morphologist, and the patient zeal and ingenuity of the experimental physiologist, a combination, let us hope, that shall unlock not a few of the secrets of the world of life."

"It is unquestionably true that the tendency within recent years" says Ward "has been to make the university trained scientist a laboratory man, unacquainted with work out of doors and among living things. * * * Thus, both through the influence of the investigators in the case of those stations which do not carry on directly any educational work, and through the teaching of those which do conduct summer instructional courses, new life will be instilled into the teaching of natural history throughout our country."

The Biological Station of the Indiana University was planned with a well defined object in view, the study of the variation of

the non-migratory vertebrates in some unit of environment. The station was to be located on a lake which would present well circumscribed boundaries within which the conditions were supposed to be nearly uniform at any time and from season to season.

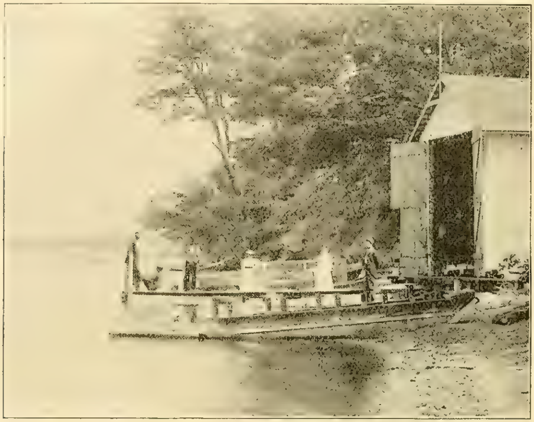


Fig. 1. The Biological Station During its First Year at Turkey Lake.

Here large numbers of all the non-migratory vertebrates were to be collected, their characteristics tabulated and compared with similar series from other lakes. We were, in short, to conduct a statistical inquiry into evolution.

Fig. 2. The Station During Succeeding Years at Turkey Lake.

For the work in hand many of the lakes were available. Our location was therefore determined by the finding of an old boathouse suitable for a laboratory on the shore of Turkey Lake.

For the first year the trustees of the university granted the use of the apparatus of the zoological department provided the station would in no way be an expense to the university. After the first year the trustees provided generously for the permanent equipment of the station. To help defray expenses a number of courses of instruction were offered for a few students. It was expected that there would be about ten in the party the first year, but there were nineteen.

The conditions for biological work, coupled with camp life on a fine lake, five miles from the nearest village and free from university lecture-hour appointments, proved so attractive that during the second summer the number of students rose from nineteen to thirty-two, and in the third to sixty-three, and in the fourth to 103, representing eight States.

Certain restrictions reduced this number to 91 during the present season. The large increase in the number of students kept us more than busy to provide for their increasing needs, but the collection of the material for the study of variation was not neglected.

At the end of the fourth year the station was moved to Winona Lake where the facilities for caring for the increasing number of students are much better. Two buildings were erected and given to the station by the Winona Assembly and Summer School. They are situated in the angle where Cherry Creek enters Winona Lake, eighteen miles from the original location. They are surrounded by a great variety of natural conditions of water, woods, swamps and meadows. The buildings are 20 by 45 feet. One or both will be lengthened to 60 feet during the winter.

FIG. 3. The Environment of the Biological Station at Winona.

The special feature in the construction is the cement floors of the ground story. This arrangement makes the tables on these floors nearly independent of people moving in any part of the buildings. On one of these floors there are private laboratories,

the lake survey laboratory and the office of the director. The lower floor of the second building is given to embryology and bacteriology. The notable feature of this floor is the (accidentally) constant temperature closet of the bacteriological laboratory. This is simply a pit beneath the stairway about a foot deep and cemented. The temperature without the use of ice did not vary more than 1° from 20 centigrade during the entire summer. The upper floor in one building is given to elementary zoology and that of the other to botany. We have small sheds for incubators away from the buildings to avoid the danger of fire. The bacteriological kitchen and the lecture room are separate tents. The most urgent need of the station is a building for general lectures and for embryology.

The water supply deserves mention. Artesian water was struck 75 feet below the surface midway between the two buildings. From this we get a flow of about 5,000 gallons per day. The water is received in a small tank and this is tapped by pipes leading to each floor of the buildings where there are small pitcher pumps. The overflow from the receiving tank leads into a larger steel tank with covers. This tank is used for experiments with blind fishes. The overflow from this leads into pools constructed for experimental work.

FIG. 4. The Buildings of the Station from the Mouth of Cherry Creek.

The springs about Winona Park flow in part into decorative pools. These will be used for the experiment in rearing cave animals in the light. One of them about thirty feet long is now inhabited by an experimental colony of blind Amblyopsis where their habits can be observed without the restrictions imposed by the conditions found in a cave.

In recognition of the fact that "the

teacher who has no time for research rapidly becomes an ineffective and uninspiring teacher, and that overteaching defeats its own ends," the instruction should be in the nature of a guiding, the giving not of a string of recipes, but of sound principles enabling the student to work out his own salvation.

Since, wherever he may go, the student must adapt himself to his environment, it is the plan to catch what we can and study what we catch rather than to follow fixed courses. The facilities for catching, however, are very favorable. We have the lake in front of us, the woods behind, the creek on one side, and a meadow on the other. Here the entire day of the student is given to collecting and exploring expeditions, lectures and laboratory work.

During the past summer courses of instruction have been given in zoology, botany, cytology, bacteriology, embryology, and survey methods. As soon as the necessary buildings can be secured, courses in neurology and comparative psychology and physiology will be added.

The department of instruction is self-sustaining, but facilities for research are still limited and here is an opportunity for some public spirited citizen.

"Research in all directions, in fact, meets with such reward that it should be sustained by all persons who desire to encourage the progress of knowledge. But the rich men of our country do not discriminate between this function and that of teaching. They found universities with princely liberality, but research has to struggle with poverty of means and deficiency of time. Great libraries are founded, but the work in the laboratory from which issue the books which create libraries receives comparatively little substantial encouragement. * * * Initiative and discovery are the conditions of progress, and no better service could be rendered to humanity than the creation of opportunities for their activity."

C. H. EIGENMANN.

SCIENTIFIC BOOKS.

Alaska and the Klondike. By ANGELO HEILPRIN. New York, D. Appleton & Co. 1899. 8°, pp. X, 315, illustrations and maps.

Professor Heilprin has given us a book which is a combination of personal travel and adventure, with statistics, a synopsis of mining laws, and other data interesting to the traveller or miner. With these, which do not especially concern the readers of SCIENCE, are some observations on the physical geography and geology which are deserving of consideration.

The author started from Skaguay by the White Pass route, July 30, 1898, arriving at Dawson, August 6th, and leaving on the 20th of September, for the outside world by the same route. The general geology of this region had previously been studied by McConnell, Dawson, Spurr, Russell and others, whose observations may be found recorded in the publications of the Dominion and United States geological surveys.

Professor Heilprin found the summer climate not unpleasant, and, *mirabile dictu*, encountered no mosquitos in the mining region. So his survey of the geological conditions was not interfered with by annoyances which disturbed the philosophic calm of most of his predecessors in the same field.

He notes conditions which confirm the opinions held by previous explorers as to the probable existence of large bodies of fresh water over much of the present placer region. The well-known bed of volcanic ash which extends for hundreds of miles along the Upper Yukon a little below the present surface of the ground, is believed by him to have been deposited in water. In the alluvium above and below it he noticed fresh water shells in a fossil state, a feature which has been observed in many places lower down the river. Though these deposits are entirely compatible with the hypothesis of the existence of an extensive lake in the region, they cannot be adduced in proof of it, since the small summer pools which are

very common on the tundra often swarm with *Limnæa*, *Physa*, *Pisidium* and *Valvata*. The marl which results is in some localities so abundant, that at Old Fort Yukon it was collected, ground up and mixed into whitewash which was used on the buildings of the original trading post, nearly forty years ago.

In the vicinity of the Klondike the author notes the hummocky appearance of the hills 'very much like magnified morainic knolls in a glaciated country,' though having a considerable elevation. Water worn pebbles and remnants of terraces up to nearly twelve hundred feet were observed by him personally.

Notwithstanding the evidences of antiquity afforded by some features of the landscape, Professor Heilprin considers that many of the more pronounced features of the region are comparatively recent. While the placer gravels of the streams and benches seem to indicate more than one denudational phase, and the principal stream-valleys are wide and open, many of their lateral tributaries are narrow and V-shaped, and the former appear to have been modified by late stream displacements. The present stream-beds, even of the Yukon, are not the most conspicuous orographic depressions but have been carved out much more recently, and it is even suggested that the emergence of the land from lacustrine conditions may have happened 'a few hundred years' ago.

The author estimates that denudation in the immediate valleys of the main streams is taking place at the rate of a millimeter a day, which, according to his computation, would equal 'a valley trough of about a foot and a third' in a single year. Allowing one hundred and twenty days for the period when erosion is not wholly prevented by congelation, the reviewer computes that the total denudation for the year would amount to less than five inches at the author's rate. Now the summer rainfall for the Upper Yukon is very small, less than an inch a month, and the surface of the ground is covered with a dense spongy mat of vegetation. There seems to be no particular reason why there should be any appreciable denudation, except in the actual beds of the streams themselves. The water of all these small nonglacial streams is notably clear, and they carry practically no sediment at the points where they enter the main river. Consequently it seems probable that the estimate of Professor Heilprin requires revision, even his second one, in which he proposes a rate of 175 feet in five hundred years. For a short period, and in certain limited portions of its bed the Yukon is able to move a considerable weight of débris, but the gravels and sands in great part antedate the existence of the present river, which has actually cut through them at but a few points in its 2000 mile course.

Professor Heilprin, in view of his limited opportunity for research, very properly disclaims any attempt to decide upon the geological structure of the region. However he devotes a good deal of space to an argument in favor of the deposit of gold in the placers, not from preëxisting stringer leads or veins in the country rock, but as a deposit, *ab initio*, from gold held in solution in water, upon or among the already deposited gravels. This is a contention which may properly be left to metallurgical experts to discuss, to the reviewer it seems unsupported by any direct evidence in this region. The author agrees with previous observers in affirming the non-glaciated character of the Klondike, and the presence of comparatively recent indications of volcanic activity. Pleistocene mammals are represented by fossil bones in the gold gravels as elsewhere in Alaska, and there is little doubt that the placer deposits as a whole are post-glacial and their material largely due to denudation by ice action during glacial times.

W. H. Dall.

The Design and Construction of Dams, including Masonry, Earth, Rock-Fill, and Timber Structures; also the principal types of Movable Dams. By Edward Wegmann, C.E. Fourth Edition, revised and enlarged. New York, John Wiley & Sons. 1899. Quarto, cloth, xii + 250 pages, 97 plates. Price, $5.00.

Many mathematicians have occupied themselves with the deduction of the shape which a high masonry dam should have in order to possess both stability and economy. Such economic profiles are of interest and value to the designer, but practically each engineer de-

vises his own economic profile to satisfy the imposed conditions. The method developed by the author is an excellent one for this purpose, leading to no complicated equations and having the advantage of constantly keeping before the computor the statical principles of stability and strength.

The fundamental assumption in these computations is that the compressive stress on the base of the dam uniformly varies from a minimum value at the back face to a maximum value at the front or down-stream face. This assumption cannot be a correct one, except in the case of a rectangular section, but it may be properly used in the absence of knowledge as to the correct distribution of stress, because its errors are on the side of safety. Strictly the base of the dam is under a shearing stress due to the horizontal water pressure as well as under a compressive stress due to the weight of masonry, and of the former no account is taken in practical computations. Probably the error in the fundamental assumption regarding the compression more than balances the opposite error, due to the neglect of the shear, so that masonry dams designed under the common theory undoubtedly possess all the needed element of security. This conclusion may be justified by the fact that masonry dams rarely fail; the author mentions but three instances of failure, two of these being constructions of the eighteenth century when the principles of design were not well understood, and the third being a case where the stone and cement were of so poor quality that leakage occurred.

Previous editions of this work were devoted entirely to masonry dams. The present edition gives additional information regarding recent structures, and also includes the description of dams of earth, timber and loose rock. For such structures few computations are needed, the size and shape being determined almost entirely by experience, while the details may vary according to local conditions and the judgment of the engineer. The numerous devices adopted in California to construct rock-fill dams without leakage are of especial interest. Movable dams of the needle, shutter, and bear-trap types are also fully described; although only a few of these have been built in America, they will undoubtedly be extensively used in future river improvements.

The work forms the most complete treatise on the subject of dams that has yet appeared. With commendable industry the author has searched the annals of engineering literature in order that no important structure might escape notice, and his list of bibliography, covering five pages, will be of value to all engineers. From the descriptive point of view, the book gives nearly all needed information regarding the important dams of the world. From the theoretic point of view, it gives everything necessary regarding masonry dams which resist overturning by virtue of their weight alone, but it is somewhat lacking in regard to the theory of arched dams. This theory, it is true, is a difficult one, but, as the Bear Valley dam in California, and the Zola dam in France, depend for their stability largely upon the arch action, a numerical discussion of their stability would have been of interest and value. Without doubt a dam arched toward the current is stronger than a straight one of the same cross-section, particularly in the emergency of ice thrust or a high flood, and it is said that the instinct of the beaver leads him to so construct them. Even if a little more material be required, it is well for the engineer to make his masonry dam an arched one and thus render the structure one of beauty as well as one of strength.

M. MERRIMAN.

The Botanists of Philadelphia and their work. By JOHN W. HARSHBERGER, Ph.D. Philadelphia. 1899. 8 vo. Pp. 457.

In this octavo volume of 457 pages we have a collection of brief biographical sketches, not only of all the people who have contributed to a knowledge of the flora of Philadelphia and the area included in a radius of sixty miles, but nearly all who have studied it afield. Commencing with such well-known pioneers as John Bartram, Humphry Marshall, Muhlenberg, Barton, Schweinitz, and Darlington, it comes down to the present members of the various botanical clubs of the city, the whole series arranged in chronological order. The Bartram Gardens, the collections of the Philadelphia Academy of

Science, the botanical department of the University of Pennsylvania, and the various field clubs are fully exploited, the pages being interspersed with numerous half-tone illustrations of points of botanical interest, in addition to many excellent portraits, the full-page illustrations amounting to forty-eight. The work is written in a pleasing style, is well printed, and forms an attractive volume. The portions relating to the earlier botanical workers who gave to Philadelphia its early botanical prestige are particularly interesting. Additional matter of general interest is found in the historical account of the scientific journals and serial publications that have been issued from Philadelphia. An interesting account of the historic trees of the vicinity closes the work.

The author is sanguine that Philadelphia 'is peculiarly fitted to be the botanical center of America,' and his references to 'the metropolitan life and publishing houses' of New York on the one side, and 'the libraries and scientific departments' of Washington on the other, illustrate well how near one can live to cities and yet fail to appreciate their most salient features.

LUCIEN M. UNDERWOOD.

The Maturation, Fertilization and Early Development of the Planarians. By WILLARD G. VAN NAME. From Trans. Conn. Acad., Vol. X., p. 263–300, pl. xxxvi.–xli. August, 1899.

The author has studied the early life history of *Eustylochus ellipticus* (Girard), and *Planocera nebulosa* Verrill with great care. The characteristic features of each structure are presented, so far as could be determined from the study of the material, which is not favorable for the solution of certain points. While the results obtained agree in the main with those of previous observers, light is thrown on a number of doubtful points. Especial mention may be made of the discussion of the centrosphere and its parts, as well as that on the interesting modifications in the form of the chromosomes. The paper is well illustrated. H. B. W.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 313th meeting of the Society was held Saturday, December 2d. W. H. Dall exhibited a specimen of the fruit of a species of *Barringtonia* stating that it was used for capturing fish, the kernel being bruised and cast into small ponds or streams whereupon the fish became stupefied and rose to the surface, where those that were wanted were gathered. The effect upon the fish was only temporary, those not taken soon recovering.

Frederick V. Coville showed an entire and a bisected cone of *Pinus alternata* both covered with lichens. Mr. Coville stated that these cones remained on the trees from 20 to 50 years and seemed to open and release the seeds only when exposed to great heat, so that no seedlings of this pine were to be seen except where the ground had been swept over by fire.

L. H. Dewey spoke on 'Frost Flowers,' saying that this name is applied to peculiar formations of ice found on certain plants on frosty mornings in fall and early winter. They are most frequently observed on dittany, *Cunila origanoides;* frostweed, *Helianthemum canadense;* marsh fleabanes, *Pluchea camphorata* and *P. fœtida*, and on the Pacific coast on the cultivated heliotrope. The first published record of the phenomenon appears to be that of Dr. Stephen Elliott, in 1824, who observed it on *Pluchea fœtida* ('Conyza bifrons') and made a note of it in his 'Botany of South Carolina and Georgia.' It has since been observed, studied and written about by many botanists and physicists. It is apparently purely physical in character, due to capillary movement of water and the action of frost, but no thoroughly satisfactory explanation has yet been given why it should be found on only about twenty-six species of plants and not on others. Further observations in the field at this season are needed to determine whether frost flowers may be found on species other than those recorded, and also further studies are needed on the structure of plants exhibiting the phenomenon.

H. J. Webber presented a paper 'The Effect of Hybridization in the Origination of Cultivated Plants,' calling attention to the remarkable development of certain of our cultivated plants, due to the effect of hybridization. It was pointed out that this is particularly true in the grape where 57 per cent. of the sorts of known parentage are hybrids while only 29 per cent.

are selected seedlings, and 14 per cent. chance seedlings, or wildlings. In pears, plums and other fruits important developments due to hybridization were pointed out, and special attention was called to the plum where a gradual amalgamation of our native plum with the Japan plum, *Prunus triflora;* and apricot plum, *P. Simoni*, is being brought about which bids fair to ultimately revolutionize plum culture. Instances were also cited where epoch-making improvements had been secured in corn, wheat, peas and tomatoes.

O. P. Hay discussed 'The Chronological Distribution of Elasmobranchs' presenting a diagram which showed by means of one set of curves the chronological distribution of the species of North American elasmobranchs and by another set the distribution of those of Europe. A table was also given which showed the genera belonging to each of the geological periods. The relationship of the paleozoic families of skates to those of the Neozoic was also considered.

O. F. COOK,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 506th Meeting of the Society held at the Cosmos Club, November 11th, informal communications were made by Dr. A. Martin on the extraction of the 4th root by successive subtractions; and by Mr. Marcus Baker, on his recent duties in Paris in connection with the Venezuelan boundary arbitration. The first regular paper was by Mr. R. H. Strother, on 'Some Observations on a Problem in Dynamics.' The problem was how a cat turns over in the air, and was illustrated by Professor Marey's photographs of a cat turning over while falling, and by a model which performs the same feat. The model consists of two cylinders of wood connected by elastic bands. Each of the cylinders describes a continuous complex motion, one of the components of which is a rotation about its longitudinal axis, the motion being such that the sum of the moments of momentum is constantly equal to zero. It is possible for a ring to describe a motion in its own plane such that its moment of momentum is zero, but involving a rotation of the ring about its center.

Following this paper, Mr. J. Elfreth Watkins gave a chapter from the early history of mechanics.

The 507th meeting was held November 25th in joint session with the Chemical Society of Washington and was devoted throughout to the Atomic Theory. Papers were read by Messrs. J. S. Ames, F. H. Bigelow, H. N. Stokes, Cleveland Abbe and F. K. Cameron. A general discussion followed, in which members of both societies participated.

E. D. PRESTON,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 295th Regular Meeting of the Society was held Tuesday, November 21, 1899.

Mr. Wm. F. Willoughby read a paper on 'The Housing of the Laboring Classes in Europe with Special Reference to France and Belgium.'

Mr. Gustavus A. Weber read a paper on the 'Housing of the Laboring Classes in the United States,' and Dr. Geo. M. Kober presented a paper entitled 'The Housing of the Laboring Classes in the City of Washington,' in which he said in part that the question of housing the wage-earners in cities is one of extreme interest to students of sociology and municipal hygiene, and the movement to supply improved, wholesome houses at reasonable rentals in the National capital owes its beginning largely to the labors of members of the Civic Center and of the Woman's Anthropological Society.

The Civic Center Committee on housing the people has for its fields of work, the investigation of the alley houses and slums with special reference to sanitary and sociological conditions, and their effect upon the health and morals of the inhabitants.

From the results of this investigation the objections to our alleys may be summarized as follows:

1. The existence of blind alleys or cul-de-sacs shutting off small communities from the outside world, and which are calculated not only to promote sickness, but also immorality and crime.

2. Insanitary conditions of the alleys and

alley dwellings, which menace not only the health of the immediate inhabitants, but also of the people residing in the same block.

3. The undue prevalence of immorality and crime, since it may be taken for granted that the majority of alley tenants suffer positive deterioration from witnessing the uncurbed vice around them.

4. High rents in proportion to the income of the families especially in consideration of the accommodations offered and the actual value of the property.

The Committee made important recommendations which were endorsed by the Central Relief Committee on January 27, 1897, and public interest was sufficiently aroused to lend to the organization of the Washington Sanitary Improvement Company, whose objects are to offer to capital a safe 5 per cent. investment and at the same time supply to wage-earners sanitary houses at reasonable rentals.

It should be stated that while the original intention was to provide homes for the alley residents and thereby remove the slums, it was considered best to begin this movement by providing improved dwellings for the better class of wage-earners, in the belief that houses vacated by them would be rented by the next grade, and so on until the bottom of the ladder was reached. It is believed that in work of this character it is always best to begin at the top. Had the company acted otherwise, the undertaking would probably have resulted in failure. As it is, the company has already erected 28 two-story flats, each constituting a distinct and complete house of three or four rooms, with bath, with separate entrance, exit, and separate yards and cellars. The company has established a high standard of sanitary homes for wage-earners at reasonable rent, and, unless other landlords pursue the same course, it will continue to supply the demand. The company grants one month's rent free to every tenant, or so much thereof as has not been expended during any one year for interior repairs. Exterior repairs necessitated by the elements are not charged against tenants. No officer of the company receives any compensation, and this, together with the exercise of strict economy and careful business methods, has enabled the directors not only to pay 5 per cent. dividends on all moneys invested in the company from the beginning, but also promoted the philanthropic aspect of the enterprise by providing the very best accommodations from the standpoint of hygiene, and as to comfort, the utmost which a given cost will permit.

J. H. McCormick,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY. NEW YORK ACADEMY OF SCIENCES.

The regular meeting of the Section was held on November 27th. The entire meeting was devoted to the presentation of papers on anthropological subjects. At the next meeting the program will consist of psychological papers.

Dr. Franz Boas reported on the Eskimo tribes of Hudson Bay according to observations made by Captain George Comer of East Haddam, Conn. He described particularly the natives of Southampton Island, who heretofore have never been visited. The arts of the tribe show a peculiar development, owing to the lack of materials with which other Eskimo tribes are well supplied. The traditions of the tribes of the west coast of Hudson Bay show remarkable analogies to the traditions of the Athapascan tribes of the McKenzie region. The well-known tradition of the Magic Flight was among those recorded by Captain Comer. There are traditions which make it clear that the Eskimos of this region believed in the transmigration of souls. The dress of the women is very remarkable, and it is suggested that the enormous pockets of their stockings may be the survivals of the custom of carrying the children in the boots, as is still done by the Eskimo of Pond's Bay.

Dr. A. Hrdlicka read a paper on the Navahoe Indians. The physical characteristics of these Indians were fully described, and a number of measurements made on fifty adult males and thirty adult females were given in detail. Observations on the life and social and industrial habits of the tribe were also presented. The language belongs to the Athapascan group. From the physical examinations it appears that the tribe, notwithstanding some evident mix-

ture, is radically allied to the ancient Pueblos and to the short-headed people of to-day in other parts of New Mexico and Arizona, and possibly in old Mexico.

Dr. M. H. Saville presented a paper entitled 'Notes on the Mexican *Codex Telleriano-Remensis.*'

CHARLES H. JUDD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

DR. WILSON ON PREHISTORIC ANTHROPOLOGY.

IN SCIENCE October 27th and November 3d, last, Dr. Thomas Wilson has committed several errors which if not corrected are calculated seriously to mislead one not familiar with the subject. The position he occupies as an officer in the United States National Museum of itself gives weight to any paper he may publish, added to which he calls special attention to his travels in Europe and his thorough familiarity with the museums and individuals who believe in a paleolithic period, his acquaintance with the Dordogne, and his many years in the National Museum, all of which he asserts peculiarly fits him to form a valuable opinion in any comparison of American with European Implements. As in at least one paragraph Dr. Wilson has assailed certain assertions of the writer and has referred to the same by misquoting what has been written, opportunity should be taken to show his errors if such exist.

His subject is Paleolithic man in Europe, and America, and his existence through eons of time, only measureable by geologic periods; through all of which man chipped stone and did not know the art of grinding it; or as Dr. Wilson contends, of sawing or drilling stone, of making pottery, or of the use of the bow and arrow; that paleolithic implements are in a class by themselves. Dr. Wilson goes further than do the European archæologists; he adopts their classification and holds up a danger flag to Americans who would deny the existence of evidence of a paleolithic period in America. The writer's denial that European classification is based on sound scientific reasoning he strenuously combats.

Dr. Wilson is one of ten or a dozen members of the Anthropological staff of the United States National Museum, and though the majority of that staff have had equally as good opportunity to study the American branch of the subject, and several of them far better than he, he stands alone in his views. He takes exception to the writer's opinion that the art of chipping stone, technically considered, is more difficult than is pecking and grinding. Yet all experience as well as all implements employed by savage races wherever found, show that the tools used in chipping are complicated, whereas a simple discoidal hammer constitutes the sole implement employed in pecking and battering stone and is found in all countries throughout all periods. No one has suggested the reversal of the paleolithic and neolithic periods for the simple reason that such classification is illogical, it would argue the absence of man during the whole paleolithic period from the areas of metamorphic stone on the continent as such stone does not chip. All experience teaches that man of the stone age wherever found was thoroughly acquainted with the artificial fracture of the available material of his vicinity whether for chipping flint, for battering diorite or kindred stones, or for hammering copper which to him was but a malleable stone. In chipping flint and similar stones, the artificial fracture varies enormously, even in the same ledge, and consequently is treated invariably in the way best suited to its peculiar texture. The present classification of stone age periods has become bewildering chiefly because of its many divisions and subdivisions. Many of these are very useful and suggestive especially that of Thomsen of Denmark who divided the human periods into Stone, Bronze and Iron, but when we read Paleolithic, Neolithic, Prehistoric, Copper, Eolithic, Upper and Lower Tertiary, the same of Quarternary, Mesolithic, Acquitanean, Sortorian, several classes of Lacustrian and a host of Cave periods, named from animals present, or from the type of stone implements found, it must be admitted the series become difficult to remember. This list is but partial and if it were necessary could be greatly increased, but, however useful for local purposes or for a single country, it will not answer for general stone age conditions. Adrien de Mortillet made a most valuable contribution

when he formulated a classification according to the function of the implement, as by pressure, friction, etc. De. Mortillet's classification was elaborated by Holmes. The present writer classified human periods and conditions by showing that nature in its stone, bone, shell, and vegetable products furnished practically all primitive material, with which man could perform such labor as conditions required, as to cut, crush, color, pierce, bind, contain, etc., as knives, hammers, paints, thorns, thongs, vessels and similar primitive implements, which in combination with one or other material became special and in time complex tools, and eventually machines, as human culture increased. In this no effort was made to reverse accepted classification, but an effort was made to show that to insist upon it could only lead to inextricable confusion.

European archæologists deny the finding of ground tools in quaternary strata, and account for their alleged presence by asserting the intrusion through water, by the burrowing of animals, or by the want of scientific training of their discoverers; but the chief objection is that because ground they must be neolithic. In areas where only non-chippable stone is found it is argued that this constitutes evidence that paleolithic man never was there present. If only chipped stones are found, the argument is made that that of itself is proof of the presence of paleolithic man only. The specimens of river drift implements in American museums are quite commonly wastrels, due to the presence of knots or refractory spots in the stone, and can not be improved upon by the most skillful manipulation.

The Mousterian specimens found at La Madelaine, though commonly considered as being rudely chipped, owing to their being worked on one side only, resemble greatly the yet ruder chipped obsidian objects from Easter Island, which if struck upon the opposite side to that from which chipped, are destroyed by fracturing along lines of lamination or natural cleavage. This inferior texture has led many to suppose the American Indian to have been an inferior stone worker, though the contrary is proved by many specimens of obsidian, jasper and chalcedony from the west and southwest. Notwithstanding the rude chipping of the cave of La Madelaine, it was inhabited by people who were skillful artists in the working and etching of bone, antler and ivory compared by any standard. In this cave and in that of La Bicheaux-Roches near Spy in Belgium, and elsewhere, there have been found at the very bottom, with the oldest of the extinct cave fauna, elaborately carved and bored antlers commonly called Batos-de-Commandement, bone pins with eyes and without, toggles, and other objects of known and unknown use, skillfully made from bone, antler and ivory. This ivory, antler and bone is much more difficult to grind, saw or smooth than is the average neolith, yet is sawed, ground, smoothed and bored notwithstanding.

Dr. Wilson himself refers to bored or drilled teeth among the tertiary remains presented by L'abbé Bourgeois. Near the bottom of the cave at Spy were found plates of ivory representing seals, ground ochre in a hollow bone, and three pieces of burned pottery. In Belgium, in Wurtemberg, in France, in Baden, many of the most distinguished archæologists have recorded the finding of pottery repeatedly.

The existence of plateau man, either in England or France before the present rivers began to form valleys, has but little evidence to support it.

Similarity of implements in widely separate parts of the earth is accounted for by similarity of man's needs, and the natural supply of most regions furnishing objects to pierce, cut, hack, or pound with or even to supply covering, in the abundance of shells, stones, trees and animals to furnish the great essentials of human life. And this similarity of man's tools appears to be due more to his efforts to imitate nature and its products, than to any inter-communication of races or nations carrying their trades from continent to continent throughout all times, and can not be designated as materialism. The suggestion of two invasions of America from Europe, one corresponding to the chipped, and the other to the ground stone area, will find few supporters.

Dr. Wilson's belief in man of the Trenton gravel and elsewhere in America belonging to the paleolithic period has its supporters, though

the fact that one of the most expert of the assistants of the Bureau of American Ethnology spent a whole season in the great ditch dug through this gravel without finding a single specimen, is a powerful argument in favor of the contention of Holmes and McGee that those found are from the talus or within a few feet of the surface.

The finding of pottery, arrow and lance heads, and axes with Koch's mastodon in Missouri can not be said to be a scientific argument in support of a paleolithic period during which Dr. Wilson asserts man did not possess three of the four objects enumerated, it appears equally true that the drilled objects of Bourgeois hardly strengthens the theory of tertiary man if we follow correctly the argument.

European drilling, all things considered, appears to have been accomplished with better tools than were those of America, and the holes were commonly larger and drilled through harder stone than were those drilled in America. We can not expect to find any of the remains of man in the gravel of the drift which has usually ground to powder all other stones softer than flint, and the Calaveras skull alleged to be found in the auriferous gravel could hardly have survived; even the pestles and mortars found with it were like those of to-day and the skull is said not to present the appearance of a fossil.

J. D. MCGUIRE.

ELLICOTT CITY, MARYLAND.

A NATURALIST'S DIRECTORY.

A BOOK which recently came to this library was called to the author's attention a few days' ago. The book is entitled 'The Naturalist's Directory' and is published by L. Upcott Gill, London, 1899. In the preface it is stated that the object and purpose of the book has been so enlarged as to include all naturalists, especially of Great Britain, and we were lead to believe by this preface that the book might be of value as a directory to naturalists in general. When, however, we turned to the lists of naturalists outside of Great Britain, we were at once impressed with the incompleteness of the work, and this incompleteness is especially noticeable in the case of the United States.

Under the general head of zoology, which includes entomology and mere collectors, as well as scientific zoologists, only thirty-three names are mentioned as pursuing this line of work in the United States. Of these names only eight or ten are of men who are at all well known. In the subjects of Microscopy and Botany, we were astounded to find that only three men in the United States were pursuing these branches of science. Of these names two are well known. According to the lists of workers in geology and paleontology, we find that the United States can boast of six men to grace these professions. Besides these interesting discoveries, we notice that there is one gentleman in the United States who is interested in Indian relics, and one other gentleman who is making a study of anthropology.

It would seem as if even in such a far away town as London, more complete information might be obtained concerning the status of scientific work in this country

E. V. WILCOX,

U. S. DEP'T OF AGRICULTURE.

DR. G. W. FOSTER AND THE 'LAKESIDE MONTHLY.'

TO THE EDITOR OF SCIENCE:—I have read with much interest, in your issue for November 17th, the sketch of my old friend Dr. J. W. Foster. One statement, however, needs correction: that "he was the editor of the *Lakeside Monthly.*" Dr. Foster was for a year or two a frequent and valued contributor to the *Lakeside*, but was at no time its editor.

FRANCIS F. BROWNE.

BOTANICAL NOTES.

THE WILT DISEASE OF COTTON, WATERMELON AND COWPEA.

A FEW days ago Dr. Erwin F. Smith, of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, issued an important contribution to our knowledge of the fungi which produce plant diseases. After about five years of investigation enough facts are known to warrant the publication in a pamphlet of seventy-two pages of what the author calls a condensed account of the disease, and the fungus which causes it. The gross symptoms of the disease in the water-

melon "are those of a plant transpiring freely, and insufficiently supplied with water, although at the same time there is an abundance of water in the soil." This condition is brought about by the clogging of the vessels of the plant by the threads of an internal fungus parasite, thus checking the current of water which otherwise would supply the transpiration loss. The leaves of the plant sometimes wilt suddenly in large numbers, "so that a healthy-looking vine may lose all of its foliage in twenty-four to forty-eight hours."

The fungus concerned is a Nectria-like plant related to *Nectriella* and *Melanospora*. Its closest relationship is with Rabenhorst's genus *Cosmospora*, from which it differs in its non-septate ascospores. Dr. Smith proposes the name *Neocosmospora* for the genus. Accordingly the scientific name of the fungus is *Neocosmospora vasinfecta* (Atk.) Smith. Ten fine plates (one colored) illustrate the paper.

THE FERTILIZATION OF *Albugo bliti*.

IN the September and October numbers of the *Botanical Gazette*, Mr. F. L. Stevens publishes an important paper which adds to our knowledge of the fertilization of the Peronosporeæ. As is well known, these plants are non-septated, branching tubes, containing multitudes of minute nuclei. The behavior of the nucleus is everywhere an interesting phenomenon, and it is especially so in these multinucleate plants. In ordinary plants and animals in the process of fertilization there is a union of two nuclei, *i. e.*, the oösphere, or *egg*, and the sperm, or male nucleus. In the plants studied, the oögone contains about 300 nuclei at the time when it is cut off from the remainder of the fungus thread, and these are materially increased by subsequent mitotic division. By a process of differentiation most of these nuclei come to lie outside of the oösphere, but fifty or so remain within it. The antheridium contains at first about thirty-five nuclei, which increase by mitotic division to four times the original number. On the opening of the antheridial tube the male nuclei fuse with the female nuclei in pairs. The oösphere is, therefore, to be regarded as a compound sexual organ.

THE OTTAWA ARBORETUM.

THE Catalogue of the Trees and Shrubs in the Arboretum and Botanical Garden at the Central Experimental Farm, at Ottawa, Canada, prepared by Wm. Saunders and W. T. Macoun, is an interesting contribution to the subject of experimental forestry. It contains a list of the trees and shrubs, 3071 kinds, which have been tested at Ottawa during the past ten years. Of these 1434 have been found to be hardy, 361 half hardy, 232 tender, 307 winter killed, while 737 have not been planted long enough to admit of an opinion as to their hardiness. Among the species reported as hardy, contrary to our expectations, are the following: *Æsculus glabra*, and other species of the genus; *Catalpa bungei* and *C. kæmpferi*, *Castanea dentata*, *Halesia tetraptera*, *Morus alba* and *M. nigra*, *Rhus cotinoides* and *Ginkgo biloba*.

THE SPREAD OF FORESTS IN NORTHEASTERN IOWA.

IN an interesting paper on the forest trees of Dubuque county, Iowa, in the forthcoming tenth volume of the Report of the Iowa Geological Survey, Professor Macbride first discusses the forest conditions of the past with narrow belts of trees along the streams and protected bluffs. He then says: "On the advent of civilization, the checking of prairie fires gave the forest here as elsewhere great relief. Young trees came up in every direction, partly from seeds, partly from so-called bench-grubs, old stump-like stocks which had been in the days of prairie fires again and again burned off, only to start again in shoots and suckers with the advent of spring; but destined so long as fires swept over them, never to attain tree-like dimensions. These bench-grubs sometimes were very old and possessed an extensive root system. This accounts in part for the rapidity with which the forests of Iowa began to spread with the arrival of civilized man. In the case before us the early farmers selected, of course, the more level country; the steeper and poorer hills were left to nature and became quickly forested, covered with what is called second-growth, an assemblage of trees denser and darker than ever occur in nature under any other circumstances. In Julien and Peru town-

ships some of these second-growth forests may yet be seen which have been growing at least fifty or sixty years. So that the oft repeated remark as to the number of Iowa trees, to the effect that their number has greatly increased since the country has been settled, is strictly true."

CONTRIBUTIONS FROM THE NATIONAL HERBARIUM.

THE Division of Botany of the United States Department of Agriculture has issued another of its series of Contributions from the National Herbarium which have done so much to raise it in the estimation of the scientific men of the country. The present bulletin (Vol.V., No. 4) is mainly from the pen of J. N. Rose, and deals mostly with Mexican plants. In his studies of Mexican and Central American plants, the author proposes a rearrangement of the genera of the difficult group Agaveae, illustrating each with one or more wood cuts. Another interesting division of this paper is that on 'Some Mexican species of *Thalictrum*.' Perhaps the most attractive paper in the bulletin is that entitled 'Notes on Useful Plants of Mexico.' This takes up in order the cereals and vegetables, fruits, beverage plants, seasoning and flavoring plants, medicinal plants, soap plants, tanning and dye plants, fiber plants, brush and broom plants, fence and hedge plants, plants, yielding wool, and miscellaneous useful plants. The principal fence plant appears to be the giant cactus bearing the name *Cereus pectenaboriginum*, which often reaches 15 to 20 metres (45 to 60 feet) in height, and sends up a multitude of long, naked branches. These are cut into lengths of 18 to 20 dm. (5 to 6 feet) and set in rows where they root and form fences of the most impenetrable kind. Several fine photographs of this cactus, reproduced in half tone give one an excellent idea of its appearance. The text and half tone illustrations of fibre plants are equally instructive. One is struck with the ingenuity displayed by the people in utilizing the fibre plants of the country, and at the same time with the primitiveness of the methods employed.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

UNITED STATES GEOLOGICAL SURVEY.

IN forwarding Part II. of the 19th annual report of the U. S. Geological Survey, which we hope to review later, the director, Dr. Chas. T. Wolcott writes:

Of its contents (five papers), the first 'Physiography of the Chattanooga District, in Tennessee, Georgia and Alabama,' by C. W. Hayes, sets forth the results of a study of a region in which several distinct types of land surface are characteristically developed under such conditions that the part taken by the several factors can be fairly well determined; it traces the process of drainage development and the origin of the present land forms upon rocks of diverse erodibility and diverse structure; and, finally, by a concurrent examination of drainage and surface, reviews the recent geologic history of the region.

The second 'Principles and Conditions of the Movements of Ground Waters,' by F. H. King, contends that the water which occupies the interior of the earth's crust, is, like that of the ocean and of the atmosphere, constantly in motion. These motions are at once numerous, extended and very complex, and are brought together and discussed under three categories, gravitational, thermal and capillary.

The third, 'Theoretical Investigation of the Motion of Ground Waters,' by C. S. Slichter, relates to an investigation of the general problem of the flow of water through porous soils of rock.

The fourth is entitled, 'Geology of the Richmond Basin, Virginia,' by N. S. Shaler and J. B. Woodworth. The Richmond area is important from the economic as well as the scientific point of view. It contains the only freely burnable coal lying immediately adjacent to tide water in the eastern portion of the United States. The quantity and quality of this fuel appear sufficient to give it a value in the industrial arts.

The final paper, 'The Cretaceous Formation of the Black Hills as indicated by the Fossil Plants,' by L. F. Ward, with the collaboration of W. P. Jenny, W. M. Fontaine and F. H. Knowlton, presents a brief historical review of the investigations of earlier explorers, followed by specific chapters on the Minnekahta, Blackhawk

and Hay Creek regions, general observations on the Cretaceous flora, fossil cycadean trunks, fossil forests, lower Cretaceous plants other than cycadean trunks and silicified wood, and the flora of the Dakota group proper.

PROFESSOR VIRCHOW'S JUBILEE.

THE Berlin correspondent of the *British Medical Journal* writes: It was to be expected that Rudolf Virchow's Jubilee—the 50th anniversary of his tenure of office as Professor Ordinarius—would not be passed over in silence by the University of which he is, perhaps, the most illustrious member. No banquet or similar social function took place, it is true; nor was there any array of State delegates or representatives of foreign universities. In the hall of the Pathological Museum (Virchow's own creation) the Senate of the University, its Rector, Professor Fuchs, at their head, assembled to greet their revered and honored colleague, and to present an illuminated and illustrated address, the text of which had been written by Professer Waldeyer. In it Virchow's wonderful many-sidedness, and his achievements as scientist, archæologist, and politician were recounted in glowing terms. "We all know, however," the address went on to say, "that the roots of your strength lie in your work as a German Professor, and ever the 'Professor' has been foremost with you. We know that, even in your 78th year when the day's work is done, the night hours are devoted by you to scientific research * * * Thus we see you to-day in our midst, the Professor Ordinarius of five decades, active among the most active, beloved, honored and admired by thousands of pupils, colleagues, and men of all orders in every part of the world. In honoring you, who in your long, laborious life have ever had at heart the honor and weal of the German universities, and above all of the Alma Mater, Friederica Guilelma Berolinensis, we honor ourselves. May your strength be long preserved to us!" Virchow, who was surrounded by his family and many personal friends, in his reply gave expression to his thanks for the support which he had always met with on the part of the university, and said it was true that his chief feeling had ever been that of 'the Professor.' In cases of conflicting interests he had always chosen the course of 'Professor.' He said that, like others of his age, he was sometimes conscious of a certain isolation, many friends and fellow-workers having gradually fallen out of the ranks. But the best results of his work had always been due to the independent efforts of his pupils, and he had the firm hope that the pathological school of Berlin would retain its distinguished position. In the evening the Berlin Medical Society did homage to its President (Virchow) by a graceful little spontaneous ceremony. The Presidential chair was wreathed and decorated with flowers and garlands, and the Vice-President, Professor v. Bergmann, greeted Virchow with a speech full of hearty good feeling, respect and admiration. Virchow seemed sincerely touched, and expressed his thanks in a short speech. Subsequently, he took a prominent part in the evening's debate on Organo-therapeutics, thus proving mental unimpaired activity even at the end of a day of ovations and congratulatory speeches.

SCIENTIFIC NOTES AND NEWS.

THERE will be a meeting of the general committee of the American Association for the Advancement of Science at Yale University, New Haven, Conn., on December 28th at 4:30 p. m. It will be the sad duty of the committee to elect a president to fill the vacancy caused by the death of Professor Edward Orton. Immediately following the meeting of the committee a meeting of the Council will be held to consider the general business of the Association.

THE desirability of forming a western branch of the American Society of Naturalists, with the same objects and conditions of membership as the main society, has long been under consideration by the naturalists of the Central and Western States. For the purpose of starting such a branch, if it seems, on discussion, desirable (the main Society acquiescing), a call has been issued for a meeting of members of the American Society of Naturalists and affiliated scientific societies living west of the Alleghanies and of others interested in providing for an annual meeting of the western naturalists; the

present meeting to be held at the Hull Biological Laboratories, University of Chicago, Thursday and Friday, December 28 and 29, 1899.

The provisional programme is as follows:

Thursday: 10 A. M.—General meeting in Botany Building, for organization and reading of papers. 3 P. M., Discussion: Methods and Results of Limnological Work. 6:30 P. M., Dinner at the Quadrangle Club. *Friday:* 9:00 A. M.—General meeting for reading of papers.

Naturalists are requested to send titles of papers to C. B. Davenport, 5725 Monroe Avenue, Chicago.

The committee in charge of the arrangements consists of Professors C. R. Barnes, H. H. Donaldson, S. A. Forbes, Wm. A. Locy and Jacob Reighard.

PROFESSOR S. W. STRATTON, of the University of Chicago, has recently been appointed Inspector of Standards, Bureau of Weights and Measures, in the corps of which the Superintendent of the United States Coast and Geodetic Survey is the official head. In accepting this position Professor Stratton takes immediate charge of the United States Office of Weights and Measures at a most opportune time. This Office has long had in its custody the national standards of length and mass and has done much valuable work for science and the arts, which has been the logical outcome of this custody. Within the last two years the Office has taken up vigorously the matter of standards for electrical measurements, has acquired apparatus and made special studies, and is now ready to do valuable work along that line. It is especially well supplied for measurements of resistance of the highest degree of accuracy. Aside from this departure from the traditional policy of the Office there is a strong, well-founded and steadily-growing demand for a radical extension of the scope of the Office, which will doubtless be answered in the affirmative in the near future under the leadership of Professor Stratton.

THE deputation which was appointed to visit the United States and Canada with the view of inquiring into the working of some of the leading universities returned to Birmingham on December 7th. When Mr. Andrew Carnegie made his donation of £50,000, he suggested that some of the features of the American universities should be incorporated in the proposed Birmingham University, and Mr. G. H. Kenrick, Professor Poynting, Professor of Physics, and Professor Burstall, Professor of Engineering at Mason University, were deputed to make the necessary inquiries. They left Birmingham on November 1st, and visited Cornell University, the Massachusetts Institute of Technology, McGill University, and the leading colleges and schools in Chicago, Baltimore and Philadelphia, concluding their tour at New York. The deputation will present a report to the University Committee embodying their views.

DR. YERSIN, well known for his researches on the plague, has been charged by the Government of Cochin China with a special mission to Java.

PROFESSOR JOSIAH ROYCE goes to Europe again this Christmas to complete his course of Gifford lectures at the University of Aberdeen.

DR. HERBERT M. RICHARDS, instructor in botany at Barnard College, has unfortunately been compelled by ill health to relinquish his courses and has sailed for Europe.

PROFESSOR HELMERT, director of the Geodetic Institute of Berlin, has been elected a member of the Royal Astronomical Society of London.

PROFESSOR JOHN M. COULTER, who is spending his vacation at Washington, will shortly publish *Plant Structures*, a book for secondary schools and colleges, this following his other recent publication, entitled *Plant Relations.* Professor Coulter has just completed *Synopsis of Mexican and Central American Umbelliferae,* now in the hands of the government printer. He expects a revision of *North American Umbelliferae*, a large volume, to be published by the Smithsonian Institution. Before he returns to the university in April, Professor Coulter expects to publish *Special Morphology of the Seed Plants*, a university text-book upon which he has been working for a number of years.

Dr. T. E. Thorpe has been appointed to succeed the late Sir Edward Frankland in the work of analyzing the water supplied by the London water companies. Dr. Thorpe is Principal of the Laboratory Department in connection with the Inland Revenue Offices, and was formerly Professor of Chemistry of the Royal College of Science of South Kensington.

Frederik Mauritz van der Wulp, the celebrated Dutch dipterologist, has died at the age of 80 years.

The death is announced of Frau Anna von Helmholtz, the widow of the late Hermann von Helmholtz.

A cablegram to the New York *Herald* from Lima, Peru, reports that Professor Miguel Fort, of the Lima School of Mines, lectured on December 3d before a large audience on the discoveries made during his recent visit to Cerro de Pasco. He brought forward evidence of the existence in Cerro de Pasco of rich deposits of gold, silver and copper.

During the past summer the University Geological Survey of Kansas made extended examinations in the lead and zinc mining district in the vicinity of Galena, preparatory to issuing a full report on the subject. Professor Haworth and five assistants from the State University spent the entire summer in the field, and were successful in gathering a large amount of data, much of which will be entirely new to the mining world.

It is announced that the plague has appeared at Lourenco Marques, the Port of Delagoa Bay. The spread of the disease among the armies in South Africa is thus rendered possible. The plague is now also reported from Algeria. The deaths in India still amount to about 5000 a week.

A museum for children to illustrate the sciences has been opened in Bedford Park, by the Brooklyn Institute. It contains exhibits in botany, mineralogy, geology and zoology.

Dr. G. A. Dorsey, curator of anthropology, Field Columbian Museum, accompanied by an assistant and the Rev. H. R. Voth, left Chicago December 6th for the Pueblo of Oraibi, Arizona. The aim of the expedition is to secure additional ethnological material, to witness the approaching solstice ceremony in order to get suggestions for new groups, and also to start a systematic and somewhat extended excavation in order to strengthen the archæological exhibit from this interesting region. The expenses are covered by Mr. Stanley R. McCormick, of Chicago, who has placed $5000 at the disposal of the Museum in addition to the $10,000 already expended on the Hopis. The splendid exhibit filling three large halls is drawing crowds of visitors and attracting wide attention.

Mr. George Byron Gorden started for Central America, December 5th, on an archæological expedition under the auspices of the Peabody Museum of Harvard University. It is hoped that an arrangement may be made by which explorations can be renewed at the ruins of Copan, where the museum has done such important work during previous years.

Archæological explorations have been carried on, along the Sound and lower Hudson Valley during the past season, by Mr. M. Raymond Harrington, son of Professor Mark Harrington. These have been for the American Museum of Natural History and have brought to light a number of Indian burials as well as specimens from the shell-heaps.

Captain Desy has returned to London after two years spent in exploring in Central Asia more especially the unknown parts of the Yarkand River.

The Goldsmith's Company has made a further grant of £1,000 to the Royal Institution of Great Britain, for the continuation and development of original research, and especially for the prosecution of further investigations of the properties of matter at temperatures approaching that of the absolute zero of temperature.

Lady Prestwich, widow of Sir Joseph Prestwich, has bequeathed £500 for the public museum at Forres.

A commercial museum is planned for Berlin under government auspices. Branches may be established at Hamburg and Stuttgart.

An Industrial Museum is soon to be established in the City of Mexico under the auspices of the Government. The museum will occupy the old church edifice of Betlemitas, on San

Andres Street. It will contain extensive exhibits of the mineral, agricultural and manufacturing products of Mexico.

THE fourth annual meeting of the New York State Science Teachers' Association will be held at Syracuse, N. Y., on December 28th and 29th. A varied and interesting program is promised. The address by the President Professor LeRoy C. Cooley, of Vassar College, will be given on Thursday evening. The subject for discussion for the first morning is the sequence of the sciences in the secondary school curriculum, opened by Principal T. B. Stowell of the Potsdam Normal School. On Thursday afternoon sub-committees will report on the teaching of zoology and of chemistry in the secondary schools. On Friday morning the subjects to be taken up are 'Earth Science in the Secondary Schools,' by W. H. Snyder, Worcester Academy; 'College Entrance Requirements in Science,' Dean W. H. Crashaw, Colgate University; and 'The Training of Science Teachers for the Secondary Schools,' Professor Edward L. Nichols, Cornell University. On Friday afternoon the equipment of laboratories and the management of laboratory classes will be discussed with separate sections for the biological, physical and earth sciences. Several committees will report at the final session on Friday afternoon.

THE Physics Club of New York, which is composed of teachers of physics in the secondary schools of the city, held its fifth meeting at the physical laboratory of Columbia University on Dec. 16th.

Natural Science gives the following particulars in regard to Mr. E. R. Waite's trawling and dredging cruise under the control of Mr. F. Farnell. The cruise, or rather series of four cruises, lasted from February 18th to April 9th. The coast-line covered extended from Jervis Bay to the Manning River, and except for a trip to Lord Howe Island, the greatest distance from land was 25 miles. The depth at which the trawl was lowered ranged between 10 and 90 fathoms. The fishes were the chief objects of study; about 100 species, represented by 365 specimens were collected, and Mr. Waite's preliminary 'Scientific Report on the Fishes' was published last year as an appendix to Mr. Farnell's 'Report upon Trawling Operations.' Several species are new to the colony, while a a few are new to science. The entire scientific collections have been deposited in the Museum, and the results will be published as a Museum Memoir, towards the expense of which £400 was voted. On the last cruise to Lord Howe Island heavy weather was encountered, and the passage occupied seventy hours instead of the usual thirty-six. Mr. Waite and Mr. Ethdridge, who also was on this trip, were left on the island for eleven days, since the *Thetis* was blown to sea in the gale. They collected here some additional very interesting remains of *Meiolania platyceps*, the peculiar extinct chelonian, which is also found in Patagonia. Also by the help of Mrs. T. Nicholls they obtained an additional collection of shells. A large number of sponges, anemones, corals, gorgonias, echinoderms, crustaceans and polyzoa were collected during the cruise. The number of species was very great, and included many new or hitherto unrecorded from the coast of New South Wales.

THE *British Medical Journal* states that at a meeting of the delegates 'degli ordini medici' attending from all parts of Italy, held on October 24th, under the presidency of Professor Durante, it was resolved to send a deputation to the Prime Minister. (General Pelloux) to ask him to bring in a bill withdrawing the right to practice, even among their countrymen, from all foreign medical men (not holding Italian degrees), whose own country did not grant Italian graduates reciprocal rights of practice. General Pelloux informed a deputation next day that he would introduce such a bill immediately on the opening of the Italian Parliament, which has been summoned to meet on November 14th.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. J. H. CHAPIN has endowed the chair of mineralogy and geology at St. Lawrence University, Canton, N. Y., with $30,000. This chair was occupied at the time of his death by the late Dr. J. S. Chapin.

EX-MAYOR CHESTER WARD KINSLEY, of

Cambridge, Mass., has given $25,000 to Brown University.

The sum of $10,000 has been given to McGill University for the establishment of a research scholarship in electrical engineering.

We are glad to learn that the suit entered to break the will of the late Professor Marsh, of Yale University, has failed and that the will leaving his property to Yale University has been probated.

Columbia University will for the first time hold a summer session this year. The courses will open on July 5th and will continue until August 8th. Each course will be given daily including Saturdays and will entitle students to credit toward College and University degrees. The courses offered are as follows: botany 2; education, 5; English, 5; geography, 2; manual training, 2; physical training, 2; mathematics, 3; philosophy, 1; physics, 2; psychology, 2.

It is expected that the statutory committee will complete the formulation of the statutes for the University of London before the close of the present year and that they may be adopted by Parliament before Easter. It is hoped that the reconstituted University of London will be established at the Imperial Institute before the beginning of the summer holidays.

Professor Winslow Upton, professor of astronomy of Brown University, has been appointed dean of the college.

Mr. Grafton Elliot-Smith, B.A., of St. John's College, Cambridge University, has been appointed demonstrator of anatomy.

The Degree Committee of the Special Board for Physics and Chemistry, of Cambridge University, are of opinion that the work submitted by Walter Rosenhain, of St. John's College, advanced student, comprising the following papers: (1) Experiments on Steam-jets; (2) On the Crystalline Structure of Metals (Bakerian Lecture, 1899, by Professor Ewing and W. Rosenhain); (3) Experiments in Micro-metallurgy (by the same two authors as No. 2)—is of distinction as a record of original research.

President James B. Angell, of the University of Michigan, concluded his annual report by expressing "gratitude for the considerate treatment accorded us by the Legislature at its session last winter. Almost unanimously it raised the appropriation for our aid from the tax of one-sixth of a mill to that of one-fourth of a mill. It thus increased our annual income by about $92,500. This addition to our resources was imperatively needed to keep the University in the position it had so long held among the strong universities of the land. With our great number of students we were in sore need of some new and commodious buildings and also of additions to our faculties. The institution has been maintained with the utmost economy, at an expense not exceeding one-half or two-thirds of that of even smaller universities. The hearty support given us by the Legislature furnishes us the gratifying evidence that the commonwealth which we are striving to serve believes that we are really conferring substantial benefits upon her and upon the nation. That is our sufficient reward and the stimulus to renewed energy in the future."

The mathematical tripos and the senior wrangler appear to be such an essential part of Cambridge University, that many will be surprised to learn that the special board for mathematics has recommended radical changes. The defects of the present system, as stated by the board, are as follows: (1) The range of subjects in Part I. is excessive, and the result is that many are able to prepare only a portion of the subjects contained in the schedule. (2) The papers are made difficult so as to provide full opportunities for discriminating between the best candidates; they consequently tend to become unsuitable as a real test for many of the others. (3) The better students spend three years in acquiring an analytical facility in solving complicated and artificial questions in a great variety of comparatively elementary subjects—in fact, in mathematical gymnastics. (4) The candidates are not brought into contact with the ideas and methods characteristic of modern advances in mathematics. The Board proposes that the first part of the tripos be arranged so that it shall be taken at the end of the second year and that the order of merit be abolished.

SCIENCE

FRIDAY, DECEMBER 29, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*SCIENTIFIC THOUGHT IN THE NINETEENTH CENTURY.**

IT is an interesting fact that the life of our Association is almost coextensive with that nineteenth century of Christian civilization which is now drawing to a close. In intellectual, as in physical phenomena, we are tempted to overestimate the magnitude of near objects and to underestimate that of distant ones; but science and art tend to advance with accelerated velocity, and we are undoubtedly right in ranking the achievements of our age in science and its applications as far greater than those of any previous century.

When our predecessors assembled a hundred years ago to organize this Academy, they could avail themselves of no other means of transportation than those which were in use before the time of Homer. If the distances over land were too great for convenient walking, they were carried or drawn by horses. If they had occasion to cross bodies of water, they used oars or sails. We have been brought to our destination to-day by the forces of steam and electricity.

The harnessing of these mighty forces for man's use has transformed not only the modes of transportation, but the processes of production of all kinds of commodities.

* Address at the Centennial Celebration of the Connecticut Academy of Arts and Sciences, October 11, 1899.

It has wrought a revolution in the whole industrial system. The day of the small workshop is gone. The day of the great factory is come. Every phase of human life is affected by those arts which have arisen from the applications of science. Comforts and luxuries which a hundred years ago were beyond the reach of the most wealthy, are now available for the use of even the poor. Aniline dyes give to fabrics used for clothing or decoration colors beside which those of the rainbow are pale neutral tints. Sanitary science arrests the massacre of the innocents, and increases the average duration of human life. Anæsthetics and antiseptics take away from surgery its pain and its peril.

But, though our Association is an Academy of Arts and Sciences, it has, at least in its later life, devoted itself chiefly to the cultivation of pure science, leaving to other organizations the development of the applications of science. Fitly, then, our thoughts to-day dwell, not upon the vast progress of the useful arts, but upon the progress of pure science. Not the economic and the industrial, but the intellectual history of our century claims our attention.

I do not propose, in the few moments allotted to me this afternoon, to give an inventory of the important scientific discoveries of the nineteenth century. The time would not suffice therefor, even were my knowledge of the various sciences sufficiently encyclopædic to justify me in the attempt. I wish rather to call your attention to a single broad, general aspect of the intellectual history of our age. I wish to remind you in how large a degree those general ideas which make the distinction between the unscientific and the scientific view of nature have been the work of the nineteenth century.

The first of these ideas is the extension of the universe in space. The unscientific mind looks upon the celestial bodies as mere appendages to the earth, relatively of small size, and at no very great distance. The scientific mind beholds the stellar universe stretching away, beyond measured distances whose numerical expression transcends all power of imagination, into immeasurable immensities.

The second of these ideas is the extension of the universe in time. To the unscientific mind, the universe has no history. Since it began to exist, it has existed substantially in its present condition. Among Christian peoples, until the belief was corrected by science, the Hebrew tradition of a creative week six thousand years ago was generally accepted as historic fact. If, on the other hand, unscientific minds not possessed of any supposed revelation in regard to the date of the world's origin, thought of the universe as eternal, that eternity was still conceived as an eternity of unhistoric monotony. The scientific mind sees in the present condition of the universe the monuments of a long history of progress.

The third of these ideas is the unity of the universe. To the unscientific mind the universe is a chaos. To the scientific mind it becomes a cosmos. To the unscientific mind, the processes of nature seem to be the result of forces mutually independent and often discordant. Polytheism in religion is the natural counterpart of the unscientific view of the universe. To the scientific mind, the boundless complexity of the universe is dominated by a supreme unity. One system of law, intelligible, formulable, pervades the universe, through all its measureless extension in space and time. The student of science may be theist or pantheist, atheist or agnostic; polytheist he can never be.

What then, let us ask ourselves, has been the contribution of our century to the development of these three ideas, which characterize the scientific view of nature:—the spatial extension of the universe, the his-

toric extension of the universe, and the unity of the universe.

The development of the idea of the extension of the universe in space belongs mainly to earlier times than ours. The Greek geometers acquired approximately correct notions of the size of the earth and the distance of the moon. The Copernican astronomy in the sixteenth century shifted the center of the solar system from the earth to the sun, and placed in truer perspective our view of the celestial spheres. But, though astronomy, the oldest of the sisterhood of the sciences, attained a somewhat mature development centuries ago, it has in our own century thrown new light upon the subject of the vastness of the universe. The discovery of Neptune has greatly increased the area of the solar system; the measurement of the parallax of a few of the brightest and presumably the nearest of the stars has rendered far more definite our knowledge of the magnitude of the stellar universe; and telescopes of higher magnifying power than had been used before have resolved many clusters of small and distant stars.

If the development of the idea of the spatial extension of the universe belongs mainly to an earlier period, the idea of its historic extension belongs mainly to our century. It is true, indeed, that Pythagoras and others of the ancient philosophers did not fail to recognize indications of change in the surface of the earth. And, in the beginning of the Renaissance, we find Leonardo da Vinci and others insisting that the fossils discovered in excavations in the stratified rocks were proof of the former existence of a sea teeming with marine life, where cultivated lands and populous cities had taken its place. Hutton's 'Theory of the Earth,' which in an important sense marks the beginning of modern geological theorizing, appeared in the Edinburgh *Philosophical Transactions* in 1788, but was not published a sa separate work till seven years later. Not till 1815 was published William Smith's Geological Map of England, the first example of systematic stratigraphic work extended over any large area of country. To the beginning of our country belong also the classical and epoch-making researches of Cuvier upon the fossil fauna of the Paris basin. By far the larger part, therefore, of the development of geologic science, with its far-reaching revelations of continental emergence and submergence, mountain growth and decay, and evolution and extinction of successive faunas and floras, belongs to the nineteenth century. Far on into our century extended the conflict with theological conservatism, in which the elder Silliman, James L. Kingsley, and others of the early members of our Academy bore an honorable part, and which ended in the recognition, by the general public as well as by the select circle of scientific students, of an antiquity of the earth far transcending the limits allowed by venerable tradition.

To our century also belongs chiefly the development in astronomy of the idea of the history of the solar system. It is, indeed, true that, in the conception of the nebular hypothesis, Laplace, whose "Théorie de la Monde" was published in 1796, was preceded by Kant and Swedenborg; yet the credit of the discovery belongs not so much to the first conception of the idea as to its development into a thoroughly scientific theory. Our century, moreover, has added to those evidences of the nebular theory, which Laplace derived from the analogies of movement in the solar system, the evidence furnished by the spectroscope, which finds in the nebulæ matter in some such condition as that from which the solar system is supposed to have been evolved.

But by far the most important contribution of this century to the intellectual life

of man is the share which it has had in developing the idea of the unity of nature. The greatest step prior to this century in the development of that idea (and probably the most important single discovery in the whole history of science) was Newton's discovery of universal gravitation two hundred years ago; but the investigations of our century have revealed, with a fullness not dreamed of before, a threefold unity in nature—a unity of substance, a unity of force, and a unity of process.

Spectrum analysis has taught us somewhat of the chemical constitution, not only of the sun, but also of the distant stars and nebulæ; and has thus revealed a substantial identity of chemical constitution throughout the universe. Profoundly interesting, from this point of view, is the recent discovery, in uraninite and some other minerals, of the element helium, previously known only by its line in the spectrum of the sun. Profoundly interesting will be, if confirmed by further researches, the still more recent discovery of terrestrial coronium.

The doctrine of the conservation of energy formulates a unity of force in all physical processes. In this case, as in others, prophetic glimpses of the truth came to gifted minds in earlier times. Lord Bacon declared heat to be a species of motion. And Huyghens, in the seventeenth century, distinctly formulated the theory of light as an undulation, though the mighty influence of Newton maintained the emission theory in general acceptance for a century and a half.

When Lavoisier exploded the phlogiston theory, and laid the foundation of modern chemical philosophy, it was seen that, in every chemical change, there is a complete equation of matter. But there was in the phlogiston theory a distorted representation of a truth which the chemical theory of Lavoisier and his successors ignored. They could give no account of the light and heat and electricity so generally associated with chemical transformations. These "imponderable agents," as they were called, believed to be material, yet so tenuous as to be destitute of weight, haunted like ghosts the workshop of the artisan and the laboratory of the scientist, wonderfully important in their effects, but utterly unintelligible in their nature. It was almost exactly at the beginning of our century that the researches of Rumford discovered the first words of the spell by which these ghosts were destined to be laid. When Rumford declared, in his interpretation of his experiments, "Anything which any insulated body or system of bodies can continue to furnish without limitation, cannot possibly be a material substance," the fate of the supposed imponderable fluid heat was sealed; but it was not till near the middle of our century that Joule completed the work of Rumford by the determination of the mechanical equivalent of heat. About the same time, Foucault's measurement of the velocity of light in air and in water afforded conclusive proof of the undulatory theory of light. In these great discoveries was laid the strong foundation for the magnificent generalization of the conservation of energy—a generalization which the sagacious intuition of Mayer and Carpenter and Le Conte at once extended beyond the realm of inorganic nature to the more subtile processes of vegetable and animal life. In this connection, I may be pemitted to refer to the work of some of my colleagues, with the Atwater-Rosa calorimeter, which has given more complete experimental proof than had previously been given of the conservation of energy in the human body.

But by far the greatest of the intellectual achievements of our age has been the development of the idea of the unity of process pervading the whole history of nature. The word which sums up in itself the ex-

pression of the most characteristic and fruitful intellectual life of our age is the word evolution. The latter half of our century has been so dominated by that idea in all its thinking, that it may well be named the Age of Evolution. We may give as the date of the beginning of the new epoch the year 1858; and the Wittenberg theses of the intellectual reformation of our time were the twin papers of Darwin and Wallace, wherein was promulgated the theory of natural selection.

And yet, of course, the idea of evolution was not new, when these papers were presented to the Linnæan Society. Consciously or unconsciously, the aim of science at all times must have been to bring events that seemed isolated into a continuous development. To exclude the idea of evolution from any class of phenomena, is to exclude that class of phenomena from the realm of science. In the former half of our century, evolutionary conceptions of the history of inorganic nature had become pretty well established. The nebular hypothesis was obviously a theory of planetary evolution. The Lyellian geology, which took the place of the catastrophism of the last century, was the conception of evolution applied to the physical history of the earth.

Nor had there been wanting anticipations of evolution within the realm of biology. The author of that sublime Hebrew psalm of creation, preserved to us as the first chapter of Genesis, was in his way a good deal of an evolutionist. 'Let the earth bring forth,' 'let the waters bring forth,' are words that point to a process of growth rather than to a process of manufacture in the origination of living beings. In crude and vague forms, the idea of evolution was held by some of the Greek philosophers. Just at the beginning of our century Lamarck developed the idea of evolution into something like a scientific theory. Yet it is no less true that the epoch of evolution in human thought began with Darwin. Manifold suggestions there were of genetic relationships between different organisms, whether organic forms were studied by the systematist or the embryologist, the geographer or the paleontologist; but each and all found the path to any credible theory of organic evolution blocked by the stubborn fact that variations in species appeared everywhere to be limited in degree, and to oscillate about a central average type, instead of becoming cumulative from generation to generation. In the Darwinian principle of natural selection, for the first time, was suggested a force, whose existence in nature could not be doubted, and whose tendency, conservative in stable environment, progressive in changing environment, would account at once for the permanence of species through long ages, and for epochs of relatively rapid change. However Darwin's work may be discredited by the exaggerations of Weismannism, however it may be minified by Neo-Lamarckians, it is the theory of natural selection which has so nearly removed the barrier in the path of evolution, impassable before, as to lead, first the scientific world, and later the world of thought in general, to a substantially unanimous belief in the derivative origin of species. Certain it is that no discovery since Newton's discovery of universal gravitation has produced so profound an effect upon the intellectual life of mankind. The tombs of Newton and Darwin lie close together in England's Valhalla, and together their names must stand as the two great epoch-making names in the history of science.

Darwin's discovery relates primarily to the origin of species by descent with modification from preëxisting species. It throws no direct light upon the question of the origin of life. But analogy is a guide that we may reasonably follow in our think-

ing, provided only we bear in mind that she is a treacherous guide and sometimes leads astray. Conclusions that rest only on analogy must be held tentatively and not dogmatically. Yet it would be an unreasonable excess of caution that would refuse to recognize the direction in which analogy points. When we trace a continuous evolution from the nebula to the dawn of life, and again a continuous evolution from the dawn of life to the varied flora and fauna of to-day, crowned as it is with glory in the appearance of man himself, we can hardly fail to accept the suggestion that the transition from the lifeless to the living was itself a process of evolution. Though the supposed instances of spontaneous generation all resolve themselves into errors of experimentation, though the power of chemical synthesis, in spite of the vast progress it has made, stops far short of the complexity of protoplasm, though we must confess ourselves unable to imagine any hypothesis for the origin of that complex apparatus which the microscope is revealing to us in the infinitesimal laboratory of the cell, are we not compelled to believe that the law of continuity has not been broken, and that a process of natural transition from the lifeless to the living may yet be within reach of human discovery?

Still further. Are we content to believe that evolution began with the nebula? Are we satisfied to assume our chemical atoms as an ultimate and inexplicable fact? Herschel and Maxwell, indeed, have reasoned, from the supposed absolute likeness of atoms of any particular element, that they bear "the stamp of a manufactured article," and must therefore be supposed to have been specially created at some definite epoch of beginning. But, when we are speaking of things of which we know as little as we know of atoms, there is logically a boundless difference between saying that we know no difference between the atoms of hydrogen, and saying that we know there is no difference. Is it not legitimate for us to recognize here again the direction in which analogy points, and to ask whether those fundamental units of physical nature, the atoms themselves, may not be products of evolution? Thus analogy suggests to us the question, whether there is any beginning of the series of evolutionary changes which we see stretching backward into the remote past; whether the nebulæ from which systems have been evolved were not themselves evolved; whether existing forms of matter were not evolved from other forms that we know not; whether creative Power and creative Intelligence have not been eternally immanent in an eternal universe. I cannot help thinking that theology may fitly welcome such a suggestion, as relieving it from the incongruous notion of a benevolent Deity spending an eternity in solitude and idleness. The contemplation of his own attributes might seem a fitting employment for a Hindoo Brahm. It hardly fits the character of the Heavenly Father, of whom we are told that he 'worketh hitherto.'

In the last suggestion I have ventured outside the realm of science. But most men are not so constituted that they can carry their scientific and their philosophical and religious beliefs in compartments separated by thought-proof bulkheads. Scientific and philosophic and religious thought, in the individual and in the race, must act and react upon each other. It was, therefore, inevitable that our century of scientific progress should disturb the religious beliefs of men. When conceptions of the cosmos with which religious beliefs had been associated, were rudely shattered, it was inevitable that those religious beliefs themselves should seem to be imperilled. And so, in the early years of the century, it was said, if the world is more than six thousand years old, the Bible is a fraud,

and the Christian religion a dream. And later, it was said, if physical and vital forces are correlated with each other, there is no soul, no distinction of right and wrong, and no immortality. And again it was said, if species originate by evolution, and not by special creation, there is no God. So it had been said centuries before, if the earth revolves around the sun, Christian faith must be abandoned as a superstition. But in the nineteenth century, as in the sixteenth, the scientific conclusions won their way to universal acceptance, and Christian faith survived. It showed a plasticity which enabled it to adapt itself to the changing environment. The magically inerrant Bible may be abandoned, and leave intact the faith of the church in a divine revelation. The correlation of forces acting in the human cerebrum with those of inorganic nature may be freely admitted; and yet we may hold that there are other forms of causation in the universe than physical energy, and that the inexpugnable belief of moral responsibility is more valid than the strongest induction. The 'carpenter God' of the older natural theology may vanish from a universe, which we have come to regard as a growth and not a building; but there remains the immanent Intelligence

> "Whose dwelling is the light of setting suns,
> And the round ocean, and the living air,
> And the blue sky, and in the mind of man;"—

the God in whom 'we live and move and have our being.'

The church has learned wisdom. The persecution of Galileo is not likely to be repeated, nor even the milder forms of persecution which assailed the geologists at the beginning, and the evolutionists in the middle, of our century. And science, too, has learned something. In all its wealth of discovery, it recognizes more clearly than ever before the fathomless abysses of the unknown and unknowable. It stands with unsandaled feet in the presence of mysteries that transcend human thought. Religion never so tolerant. Science never so reverent. Nearer than ever before seems the time when all souls that are loyal to truth and goodness shall find fellowship in freedom of faith and in service of love.

WM. NORTH RICE.

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*RESULTS OF THE SECOND BOTTEGÒ EXPEDITION INTO EASTERN AFRICA.**

UNDER the auspices of the Italian Geographical Society, whose President signs the preface, the survivors of the Second Bottegò Expedition into Eastern Africa have prepared and published a narrative of their arduous journey, and an account of the results achieved at the cost of two valuable lives. The volume is well written and profusely illustrated—it is, moreover, accompanied by a series of clearly drawn maps of the country traversed, much of which had been previously unvisited by European explorers.

On his second expedition Vittorio Bottegò, accompanied by three valiant assistants—Lamberto Vannutelli, Lieutenant in the Royal Navy; Carlo Citerni, of the Italian Army, and Dr. Maurizio Sacchi, left Naples on the 3d of June, 1895, and reached Brava on the Southern Somali coast on the 1st of October of that year. Ten days later the explorers marched out of Brava with a caravan of 250 Ascaris, and on November 18th reached the outskirts of Lugh, an important emporium of trade in Southern Somaliland, situated on the River Juba in about 3° north latitude, which had been visited by Bottegò on his first expedition. Lugh, it was found was

* L'Omo. Viaggio di esplorazione nell' Africa Orientale narrato da L. Vannutelli e C. Citerni. Sotto gli auspici della Società Geographica Italiana. Milano, 1899.

at that time in possession of a band of predatory Abyssinians, who of late years, as is well known, have traversed and ravaged the whole of southern Somaliland. Alarmed, however, by the reports of the advancing caravan of Italians, the Abyssinians had withdrawn leaving Lugh in ruins and completely deserted, as the native inhabitants had taken refuge on the other side of the river. Lugh lies on a peninsula of land nearly surrounded by a bend of the River Jutz, and defended by a wall some 200 meters in length which crosses the isthmus from bank to bank. The Italians were naturally well received on their arrival as deliverers from the much hated Abyssinians, and were treated in the most friendly way. After a few days they induced the population to return to their deserted city, and reinstated the Sultan of Lugh—Ali Hassan Mir on his tottering throne. A fort was built and a guard of 45 Askari left in it for the protection of the inhabitants against further invasions while a treaty of perpetual alliance between Italy and the Lughians was drawn up and signed.

Some distance above Lugh the Juba is divided into three branches—the Ueb coming from the north, the Ganula Doria from the northwest and the Daua from the west. After a month's delay, during which an excursion up the Ueb in order to restore some captives to their friends was made by some of the party, the expedition was reunited at the end of January, and proceeded up the valley of the Daua or great western branch of the river Juba, along the caravan road which leads to the region of the lakes. On the 2d of February they crossed from the left to the right bank of the Daua, and continued thence at some distance from its banks through the country of the Garra-Somali, then passing into that of the Bóran, a race of pacific shepherds speaking a Galla tongue. Leaving the water-basin of the Daua to the left, and proceeding through the hills, the party arrived on March 17th at Ascebo—a large village of from 300 to 400 houses—on the outskirts of the Bóran country. A few days later they arrived on the banks of the Bisan-Gurracia, the first water met with flowing in a western direction. Burgi, a pleasant village in the mountain of the Amarr-Bambsla, was reached on March 30th, and the tomb of Eugenio Ruspoli, an Italian explorer who was accidentally killed there some years before, was visited.

The route taken hence was northward along the Badditu range until a new lake 'never before seen by European eyes' was discovered on May 12th. Lago Regina Margherita, as it was agreed to name this fine sheet of water after the Queen of Italy, is surrounded by lofty mountains, some of which are said to attain a height of nearly 11,000 feet. Twenty-five days were spent on the exploration of this beautiful lake, which is about 250 kilometers in circumference, and lies at a height of 4200 feet above the sea-level. Just south of it, divided by low ground, is another smaller lake—Lake Ciamò, and the two together drain into Lake Stephanie, which lies some sixty or seventy miles to the southwest of them.

On June 12th, the exploration of the new Lakes having been completed and sufficient rest obtained, the explorers were ready to proceed onwards in search of the great river Omo, to trace the course of which was one of the principal objects of their expedition. It having been ascertained that the Abyssinians were in occupation of the country to the north of the new Lake, it was resolved to proceed due west through the mountains, and a most difficult task this proved to be. The path led through mountains from 9000 to 10,000 feet in altitude, and the natives were energetically hostile. But at the end of June they had traversed the range, and found themselves on the south bank of the much sought for river

which drains the southern provinces of Abyssinia. Unfortunately the Abyssinians had become well aware of their movements, and an Abyssinian Ras, Uoldu Ghirgis stood in battle array on the north bank ready to stop them. Turning away to the west through the mountains the Italians managed with great difficulty to escape their enemies, and, though hampered by constant attacks from the natives, succeeded in reaching the Omo again, and in descending its left bank to Lake Rudolf. It was thus shown that the great Abyssinian River Omo flows neither into the Nile as had been conjectured by some geographers, nor into the Juba, as had been supposed by others, but constitutes the principal feeder of the internal basin of Lake Rudolf. That a large river entered this Lake at its northern extremity was well known from former explorations. But no one had shown its identity with the Abyssinian Omo, which was thus fully established. On August 30, 1895, the Italian travellers found themselves at the north end of Lake Rudolf in occupation of the cabin of Dr. Donaldson Smith, the American explorer, who had been in the same spot about a year before them.

The chief object of the second Bottegò expedition had thus been accomplished. The Omo had been traced to its outlet in Lake Rudolf. Besides this many miles of fresh country had been traversed, and a new and most interesting lake discovered—not only discovered, but carefully measured and mapped, as will be seen by the charts attached to this volume.

Had the voyagers gone home by the usual route through British East Africa, or returned by the way they came they would have been allowed the credit of having done excellent work. But they were still ardent for further discoveries.

In the first place a side-excursion was made by Bottegò and Vannutelli to Lake Stephanie. The river Sagan, which drains Lakes Margherita and Ciamò, and which they had struck on their former route to Burgi, was found running into the head of Lake Stephanie. It was a good elephant country, and 14 elephants were killed in five days. The tusks together with the ivory previously procured were sent off to Lugh by a Somali caravan. On October 18th the whole party was again assembled at Bumé, at the northeast corner of Lake Rudolf.

Here it was resolved, on consultation, that Dr. Sacchi should proceed home via Lugh with ivory and the scientific collections already accumulated, while the remaining members of the party should continue their explorations. Dr. Sacchi reached Ascebos safely, but on returning to Lake Margherita to fetch some ivory placed in cache there, was unfortunately killed in an encounter with the natives some four months later (February 7, 1897).

Before leaving Lake Rudolf the remaining explorers resolved to make it quite certain that no river flowed out on the western side of the lake. The western bank of Lake Rudolf was, therefore, carefully examined as far south as about 3° N. L., where the river Tirgol flows from the west into the lake. Beyond this it had been already ascertained that there was no water issuing out of Lake Rudolf, which is, therefore, a closed basin, and has no connection with the Sobat and so with the Nile, as had formerly been supposed possible.

Starting again from the north end of Lake Rudolf on December 13, 1896, the travellers proposed to make their way home through Abyssinia, little aware of the unfortunate series of events which had taken place between that country and Italy. Leaving the large northeastern gulf of the lake on their right, they arrived shortly on the river Sacchi, as they proposed to name this stream after their lost com-

panion, and ascertained that though flowing directly southwards it did not at that time actually reach Lake Rudolf, but probably passed into it only by infiltration.

For ten days the River Sacchi was ascended, through a fine and fertile country, but with few inhabitants. At about 5° 30′ N. L. this river was quitted for the adjoining mountain range on the left, and after passing the water—parting at some 5700 feet in altitude a descent was made into the valley of the Sobat or strictly speaking that of the Guibà or Acobo—one of its principal southern confluents. The Guibà was reached on January 3, 1897, in about 6° 30′ S. L. and 35° E. L. It was here found to be a stream of about 200 feet in breadth and a foot and a half deep—some 30 or 40 miles from its sources in the mountain of Caffa. The descent of the Guibà was commenced on the left bank. A few days later the stream was crossed and progress was continued on the right bank some way from the stream, which was regained at Ghira, the first village in the extensive district of Jambò. Here it was found that a tongue nearly allied to that of the Shilluks of the Upper Nile was spoken, and intercourse was opened with the natives by one of the Ascari who happened to be of a native of Fashoda, but there were great difficulties about guides. Finally it was determined to proceed to the north, and another confluent of the Sobat—the Ghélo, a limpid stream running placidly westward—was reached on January 23, 1897. On attempting to descend the Ghélo the party became involved in marshes and much harassed by hostile natives, and were obliged to return to their former quarters on the Ghélo which were regained on February 6th, after serious losses in men and baggage-animals. After a few days' journey up the Ghélo, during which a new lake, proposed to be called Lake Gessi, was discovered, that river was left, and a course nearly due north was taken which brought the party after crossing several smaller affluents on the 26th of February, 1897, to the main stream of the Sobat in 8° 10′ N. L. The Sobat or (Upeno) is here a fine stream of 900 feet in width and 3 feet in depth, flowing through a fertile and thickly populated valley. Crossing the river with the assistance of the natives, which here were still of the Jambo tribe, the party continued up the right bank for several days, and then left the river to ascend the Abyssinian mountains—which border the valley on the north. Before doing this, however, a letter was sent to the Abyssinian Resident in the adjoining districts of the Sajo asking for permission to pass through his country. In reply to this some Abyssinian soldiers were dispatched to invite the Italians to come on, and to show them the way, and shortly afterwards they met Abba Cialla, brother of the Resident, Giotò di Lega, with a large *cortège* sent expressly to welcome them. On March 16th accordingly the weary travellers arrived at Jullem, near Gobo, the residence of the Desgatch, and were most cordially received. Surely now, they thought, their long tramp had come to an end and they would have an easy passage across Abyssinia to their countrymen at Cassatà. Never were such expectations more miserably disappointed. The treacherous Abyssinians made an attack on the Italian camps on the night of March 17, 1897. Captain Bottegò was killed, Citerni was wounded, and the whole of the party either slaughtered or taken prisoners. Citerni and Vannutelli were imprisoned in irons, and most shamefully abused and treated until June 13th, when orders were received from Menelek that they should be sent up to Addis Abeba. Although these orders were complied with it was not until the day of their entrance to the capital that their chains were removed. At Addis Abeba, which was

finally reached on June 22, 1897, Vannutelli and Citerni, the two surviving members of the Second Bottegò Expedition were most cordially received by the Italian Envoys—Major Nerazzini and Captain Ciccodicola, and arrangements were quickly made for their return to Europe.

Among the perils and dangers of such a journey as this especially when the great difficulties of transport are taken into consideration, the collection of scientific specimens is by no means an easy task. Yet, as will be seen by reference to the Appendix to the present volume, the members of the Second Bottegò Expedition by no means neglected this part of their duties. After the geological, meteorological, and astronomical observations are given we find a summary of the zoological results prepared by Dr. Gestro of the Museò Civico of Genoa. These are based on specimens obtained during the first part of the journey between Brava and Lake Rudolf which, however, formed but a very small proportion of the whole collections. The Mammals have been described by Mr. Oldfield Thomas of the British Museum in two papers published in the Annals of the Museò Civico of Genoa, the first relating to 27 species and the second to 20, one of which (*Crocidura bottegi*) was new to science. The few birds saved from the wreck have been named by Count Salvadori, the Reptiles and Batrachians by Mr. Boulenger and the Fishes by Sigo Vinciguerra. Their reports have likewise appeared in the same well-known periodical. The more numerous specimens of Invertebrates have been worked out by various specialists of whose contributions the titles are given here, together with an abbreviated account of the principal novelties accompanied by many excellent illustrations. The value of this well prepared volume is further enhanced by the excellent series of maps attached to it, whereby every detail of the routes pursued may be followed with the greatest ease. The name of Giacano Doria attached to the preface is a guarantee that neither trouble nor expense has been grudged in the production of the present volume as is indeed at once evident to all that examine it.

P. L. SCLATER.

LONDON ZOOLOGICAL SOCIETY.

ON THE CHEMICAL NATURE OF ENZYMES.

THE enzymes form one of the most interesting groups of organic compounds from the physiological as well as the purely chemical point of view. Physiologically they may be classified as follows:

1. Enzymes which are intimately connected with nutrition, as diastase, pepsin, trypsin, lipase, etc.

2. Enzymes which cause oxidations—the oxidases.

3. Enzymes which bring on coagulations, the clotting enzymes: rennet, thrombase, pectase.

The first group has been known longest and best and has served certain authors for inferences and distinctions which at present are no longer tenable. Erroneous views as to the rôle of enzymes are however now and then entertained even at the present day, actions being ascribed to them which belong exclusively to the living protoplasm itself. Thus, in an article on 'Assimilation and Heredity' the hypothesis was formulated that "enzymes are the true bearers of heredity." Thus far it has been the well founded inference that the molecular arrangement, the invisible organization or tectonic of the chromosomes forms the foundation of the genetic differentiation and heredity. These chromosomes consist principally of a nucleoproteid (chromatin) of a very labile nature, that is easily converted into a stable proteid by injurious influences which cause their death. The chromatin of the chromosomes of different animals may not be identical, but only iso-

meric, or otherwise closely related (something chemically very difficult to prove), but there can be no doubt that the *tectonic* must be a different and a specific one in the chromosomes of every different kind of animal. This different construction or machinery causes those special differentiations in the further development of a fecundated egg which characterize a species,* while it is the chemically labile nature which confers the power of transforming and applying energy.

Moreover, the same author ascribes to enzymes the power to form living matter from the dead matter of the food. This, too, is not correct. The proteolytic enzymes merely provide the living animal cell with soluble protein (albumoses), but this inactive protein is converted into living matter by the living protoplasm itself (probably by the nucleus), but surely not by enzymes.

Besides the known enzymes that act on glucosides, carbohydrates, fats and true proteins, there exist certainly still others of however a rather narrow sphere of activity. Certain mites and a few fungi attack hair and horn and utilize therefore keratin as food, hence, they must be able to prepare an enzyme (keratinase), especially adapted to dissolve keratin. Certain fungi easily perforate the chitin structures of insects and a special enzyme (chitinase) has to be assumed also in this case. Still another group are the but recently recognized *bacteriolytic* enzymes, produced by certain kinds of bacteria themselves. These enzymes play an important rôle in the recovery from and immunization against infectious diseases.† Their powers of dissolving bacteria, however, are restricted to certain kinds and may in many cases act on one kind only. It is from the ecological standpoint certainly a remarkable fact, that an organism, as, *e. g.*, *Bacillus pyocganeus* produces an enzyme which, after reaching a certain concentration, dissolves the bacillus itself! The bacillus, so to speak, commits suicide by means of its own enzyme—certainly not a teleological working of nature for the maintenance of species!

* The various hypotheses treating this problem have been discussed by Ives Delage: *La structure du protoplasma et les théories sur l'herédité, etc.* Paris, 1895.

† Cf. Emmerich and Loew, Bacterolytische Enzyme als Ursache der erworbenen Immunität und die Heilung von Infections krankheiten durch dieselben; Zeitschrift für Hygiene, Vol. 31, May, 1899.

As to the *chemical nature* of enzymes three questions above all have occupied the mind of investigators, viz.: 1. Are the enzymes proteins or not? 2. How is the fact to be explained that a very small amount of an enzyme can transform a relatively very large amount of another compound? 3. What is the cause of their quite specific action, the reason that they can only attack a specific compound and not others, even closely related ones?

The importance of the first question has been much overrated and while one author asserted they belong to the coagulable albumins, another ascribed to them the nature of nucleoproteids and still others claimed that enzymes are very different from any protein matter. It is true, special difficulties are encountered in the purification and isolation of enzymes, but it is also not less true, in many cases at least, that it is quite impossible to separate the enzymic activity from protein matter. The tendency of certain authors to infer from the nature of *one* enzyme the nature of all the others also, is not justified at all. There may exist enzymes in every group of proteins, and some may exist that are not proteins, although derived therefrom.

Wurtz* has recognized papayotin, the proteolytic enzyme of Carica papaya as an albumose and Chittenden† thinks the di-

* *Comptes Rendus*, 90, 1379.

† *Transactions of the Conn. Acad. of Sciences*, Vol. 8 (1891).

gesting agent of the pineapple to be of the same nature. Pelkelharing* found that the activity of pepsin is intimately connected with a nucleoproteid and the same author as well as Halliburton declare thrombase (the clotting enzyme of the blood) to be a nucleoproteid.† Spitzer declared also the peroxidase of the animals to be a nucleoproteid,‡ which however, the writer found not to be the case with the vegetal peroxidase, which in all probability has an albumose-like nature. Seegen and Kratschmer § inferred from their investigations an albuminous nature of the diastase of the liver, while the writer found the trypsin and diastase of the pancreas gland to be of peptone character; that is to say, when transformed to the *inactive state*, they behave towards the usual reagents like a peptone, while in regard to their *activity* they differ essentially from them (see on this point further below). As to the diastase of malt, Osborne as well as the writer, || has inferred its protein character. In the purest state it was prepared by Wróblewski, who showed that it was a proteose and was formerly obtained with an admixture of a carbohydrate, araban. This author recently also proved invertase to be of a proteose or peptone-like nature. Certain authors failed to obtain with their enzyme preparations either the reactions or the composition of protein matters, which may have been due in some cases to imperfect purification, while in others the enzyme might really be no protein at all, which is probably the case with the rennet, investigated by Hammarsten. The *active* character of an enzyme is not necessarily connected with a protein nature, since the ordinary soluble proteins have no such activity at all. In analyzing enzymes we can only find the composition of the *killed** enzyme, which in fact is no longer a real enzyme. This brings us to the second of the above questions, the cause of their chemical powers. The question how it is to be explained that a small amount of enzyme can transform a relatively very large amount of another substance has been answered in various ways, none of which have proved satisfactory. We shall not enter here on a critical review of all these hypotheses, which the reader will find treated in Green's recent work: 'The Soluble Ferments and Fermentation,' (chapter 24).† Only a few points, especially regarding recent views may be mentioned, before the view of the writer is discussed.

One author declared that enzymes are not bodies, but properties of bodies (which nonsense was called by several authors an 'ingenious,' hypothesis!); another said that small quantities of enzymes are merely attached to proteins, but are not proteins themselves; another declared that the enzymes act by repeatedly causing oxidation and reduction.‡ But even if this last mentioned view were correct (which cannot be, since most enzymes can be active also in the absence of oxygen), it does not explain the power that would cause the supposed oxidations and reductions. Saccharoff, who advanced this hypothesis, made experiments with papayotin only, in which he assumes a small quantity of 'bionuclein,' an active principle, containing iron, and associated with it a larger amount of another substance that has a mere promoting action. From some very vague

* *Zeitschrift physiol. Chem.*, Vol. 22, p. 233.

† *Arch. für Physiol.*, 1895, p. 213, and *Journal of Physiol.*, Vol. 9, p. 265.

‡ *Jahresbericht f. Thierchemie*, 1897.

§ *Jahresbericht f. Thierchemie*, 1877.

|| *Pflüg. Arch.*, Vol. 27, p. 206.

* The word 'killed' is used here as a short term for 'transformed to an inactive state.'

† Recently a review of this work was published in this JOURNAL.

‡ *Saccharoff*, *Centralbl. f. Bakteriologie*, Vols. 24. and 26.

trials this author draws far-reaching conclusions and even ascribes all actions of living protoplasm to the presence of an exceedingly small quanity of 'bionuclein,' present in albuminous matters of the cells.

The writer in 1882 proposed the view that enzymes are like the protein bodies of the *living* protoplasm distinguished by the presence of *chemically labile atomic groups** and said at that time: "it seems as if some remnant of the active powers of the protoplasm must be contained in the enzymes." Later on, somebody else called enzymes 'protoplasm splinters' and since then this phrase has been echoed by many who did not conceive or concede that the principle common to both consisted in chemical lability.

The principle of chemical lability (instability) has thus far been but little studied. The writer has recently suggested the desirability of distinguishing between kinetically-labile and potentially-labile compounds.† A *kinetically labile compound* is characterized on the one hand, by the easy change to a more stable, isomeric or polymeric modification or compound, and on the other, by the great facility with which it enters into reactions with various other compounds, especially with such as also possess labile properties, whereby result products with a less degree of instability. *Potentially labile* compounds behave differently, they do not pass into isomeric or polymeric modifications, do not easily yield various derivatives, but are inclined to sudden far-reaching decomposition or explosion. Examples of the former class are aldehydes, amido-aldehydes, amido-ketones; of the latter class, the diazo-compounds and the nitrates of polyvalent alcohols as nitroglycerol. Kinetic lability comprises free chemical energy while potential lability intra-molecular chemical energy of position to be well distinguished from the potential energy relatively to oxygen, a potential energy present in all organic compounds and liberated in the act of combining with oxygen.

Chemical energy consists in certain motions of atoms, motions of larger amplitudes than the motions of heat energy, although easily passing into the latter. We must infer the larger amplitudes of chemical energy from the fact that at the ordinary temperature the chemical energy can counteract the force of affinity in a much larger measure than heat energy can do it.

Free chemical energy in a labile compound is caused by a loose position of atoms in certain atomic groups, and this loose position is the consequence of a depression of affinities on account of one atom being under the simultaneous influence of two neighboring atoms. Such atoms in loose position are subjected to much more violent oscillations under the influence of heat energy than are the other atoms in stable position in the same compound. Thus, heat energy is easily transformed into chemical energy by labile atomic groups. As the writer first pointed out, such machines to transform heat into chemical action are, *the proteins of the living protoplasm* and *also the enzymes*, the latter, however, in a much less degree than the former.

The organized proteins of the living matter produce their own heat by respiration, whilst the enzymes utilize either the free store of heat energy in the atmosphere when they act at the ordinary temperature, or also the heat of other sources when they act at an elevated temperature.

Let us now review the general chemical

Pflüger's, Archiv, Vol. 27, p. 211. Also, *Journal für praktische Chemie*, Vol. 37, p. 103.

† A detailed account of this view, explained by numerous examples is contained in Chapter 11, of the treatise of the writer: "Der chemische Energie der lebenden Zellen," recently published in Munich by Dr. E. Wolff.

properties of enzymes. Although an increase of heat up to a certain point (the optimum temperature) promotes their actions, a further rise in temperature is injurious and a still further rise stops all their actions. This is in perfect accordance with the transition of a labile to a stable modification, or even to a still more different compound, produced by atomic migrations. The labile atoms approach by their larger oscillations too closely to other atoms, the affinity of which can exert now sufficient power to produce an 'atomic migration.'* The enzymes are 'killed' at this fatal degree of intensity of heat, in other words they have lost their labile, unstable atomic groups, by 'migration' of atoms into a stable position; lability and activity cease to exist. In further analogy to many cases of transformations of labile into stable compounds, enzymes are also 'killed' by a certain amount of alkalies or acids. Different enzymes are resistant in very different degrees, however, not only to these agencies but also to other injurious compounds. This indicates either differences in the *nature* of the labile atomic groups or, what appears more probable to the writer, different positions of the labile groups within the molecule. The closer to each other they are situated, the more easily the transformation to an inactive isomeric compound will take place. The greater the intensity of chemical energy at a given temperature the more activity is possible, and the more easily the point of destruction is reached.

It seems highly probable that there exist two or even more labile groups in one molecule of an enzyme, since Jacobson observed that by a cautious application of heat their power of decomposing hydrogen peroxide may be taken away, while their specific enzymatic action may be retained.*

A few instances will illustrate the differences of resistance of enzymes: trehalmse is killed at 64° C., while inulase at about 70°, emulsian at 75–80°, diastase at 80–86°. The temperatures, however, vary considerably with the acid or alkaline reaction of the liquid, with the degree of concentration and with the presence of neutral salts, or of some organic neutral compounds. Furthermore, while pepsin resists at the ordinary temperature 2 per mille hydrochloric acid, trypsin, emulsin, diastase and papayotin are killed by less than 0.5 per mille.† On the other hand, pepsin is more easily destroyed by sodium carbonate than trypsin and rennet. Invertin is very easily destroyed by dilute alkali (Wróblewski). Hydrogen sulphide easily kills the proteolytic enzyme of *Micrococcus prodigiosus* and *Proteus vulgaris*, not, however, that of *Bacillus Milleri*, nor pepsin, diastase or emulsin.‡

The writer has observed that prussic acid of 25 per cent. kills diastase (but not trypsin) at the ordinary temperature within 12 hours. Arsenious acid is reported to have no injurious effect upon enzymes, but in the writer's opinion this question deserves further study. Certain alkaloids have also been observed to have a destructive action on enzymes. Quinine, 1 per cent. has an inhibitory effect on the action of

* Organic chemistry abounds with interesting cases of this kind. Even the first synthesis of an organic compound, that of urea from ammonium cyanate, is due to such an interesting transformation.

* *Zeitschrift f. physiol. Chem.*, Vol. 16, p. 340 (1892). Bourquelot assumes here the presence of an impurity with certain active properties which agrees with some recent tests of the writer.

† Organic acids act less energetically. Thus Wróblewski reports that invertin can resist even 4 per cent. acetic acid for some time.

‡ Cf. Fermi, *Archiv. f. Hygiene*, Vol. 14, p. 15. *Chem. Centralbl.*, 1894, I., p. 965. The writer has convinced himself that neither basic acetate of lead nor hydrogen sulphide, when applied for a short time in moderate quantities, injure diastase or trypsin, and therefore Wurtz's method may well be applied for the preparation of these enzymes, especially from the pancreas gland.

pepsin, while it does not injure diastase or oxidase. Atropine in moderate quantities makes diastase inactive.* Further, prolonged contact with alcohol injures the enzymes more or less.

The writer long ago tried to solve the question what kind of labile atomic groups cause the activity of enzymes, and had certain reasons for the supposition that the lability is due to the simultaneous presence of aldehyde and amido-groups in the molecule of an enzyme. Indeed amido-aldehydes (and amido-ketones) exhibit a high degree of lability. The usual tests for aldehyde groups failed however, but it may nevertheless be possible that these are present in the less active polymeric form.† It deserves to be mentioned in this connection that free hydroxylamnie which very easily enters into reaction with aldehyde groups, also renders diastase inactive in a diluted neutral solution. In regard to labile *amido-groups* it is to be expected that enzymes containing them would become inactive as soon as certain compounds combine with the amido-groups and change them. Such a substance is formaldehyde. Indeed, pepsin and diastase are rendered inactive when they remain for 24 hours in contact with a neutral solution of 5 per cent. formaldehyde. Other enzymes, as emulsin, papayotin, trypsin, etc., yield in its presence inactive precipitates.‡ These observations were later on, made also in the Institut *Pasteur* without, however, any attempt to draw a further inference. In the opinion of the writer however, this behavior makes the presence of labile amido-groups highly probable.

If we now take into consideration the fact that the study of the cleavage products, obtained by boiling with acids or alkalies, or the elementary analyses, can only clear up the composition of the *killed enzymes,* while it leaves us completely in the dark as to the nature of the labile active groups in the original enzymes, we must feel surprised at the attempts to find by simple analysis the true nature of the chemical power of enzymes.

The denial of the protein nature of enzymes on the ground that they are more easily changed by injurious influences than are the proteins is also a source of surprise. Several passages may here be quoted to show the opinions of recent physiologists. Thus we find in an article by a German physiologist the following passage: "There is no reason to doubt that as soon as an analysis of the enzymes has been accomplished, their synthesis will be accomplished too." And in a recent work of an English physiologist we read: "Some serious objections to the view that enzymes are proteids can be based upon the action of light upon them. Diastase is injured by direct sunlight, proteids are not." *Both these views are unqualifiedly erroneous.* Enzymes of protein nature are not ordinary passive proteins, but proteins with labile atomic groups. Only the changed (*killed*) enzymes can be classified with the *ordinary* proteins.*

As soon as we understand the close connection between lability and activity, and that enzymes are capable of transforming heat energy into chemical energy, we can also by means of Helm's principle of the intensity of energy understand that their chemical energy may be transferred to other compounds. And when these other compounds are of such a character that

* Detmer, *Landwirthshaftliche, Jahrbücher*, 1881.

† Nencki and Macfadyen observed with one enzyme only, viz., one derived from the cholera bacillus, a reduction of an alkaline silver solution (1891), while Brieger obtained a phenylhydrazone with a protein contained in a culture of the microbes of diphtheria.

‡ O. Loew, *Journ. f. prakt. Chem.*, Vol. 37, p. 704 (1888).

* The writer makes use of the proposed distinction between *protein* and *proteid.* Protein is the general name for all protein matter, while proteid signifies exclusively the more complicated kinds containing phosphoric acid, sugar, etc. (nucleins, mucins, etc.).

their atoms are easily set in motion, we can further understand that, by thus lessening certain affinities in them, another grouping of atoms may result.

It thus becomes intelligible why one molecule of an enzyme can, like a machine, change innumerable molecules, one after the other, of another compound. The chemical changes produced consist either in depolymerization, as in the production of dextrin from starch, or in hydrolytic action, as in the conversion of maltose into glucose, or in a further splitting combined with atomic migration, as in the production of amido-acids and bases from protein by trypsin.

Such chemical action produced by the mere transmission of chemical energy by a certain substance, which remains chemically unaltered, but acts like a machine, are called *catalytic*. We know that such actions are produced by finely divided metals, by alkalies and strong acids and that such are also produced by labile organic compounds. Thus, for instance, an aqueous solution of ethylaldehyde transforms dicyanogen rapidly in oxamid without undergoing a change itself (Liebig). Finely divided nickel splits acetylene into carbon and hydrogen,* finely divided platinum splits hydrogen peroxide into water and oxygen, etc.

We may now consider the third of the above questions: *How can the specific action of the enzymes be explained?* How is it, for example, that diastase can saccharify starch but not inulin, that inulase can saccharify inulin but not invert cane-sugar, that invertase can invert cane-sugar but not milk-sugar? Here the principle of the configuration of the molecules comes in. The closer the contact, the more perfect a transmission of energy is possible. The molecular adhesion, however, is enhanced by a certain coincidence of the surface features of the molecules. The writer in the year 1893 applied this principle to explain the fact that certain alkaloids have in very small quantities an effect only upon certain nerves, but not on all nerves, nor upon glands or muscles.* Later on, E. Fischer applied the same principle to the specific action of the enzymes, adopting the comparison to lock and key. However, *Fischer did not discuss at all the question* how enzymes can develop their energy nor did Green in his recent work: 'Soluble Ferments' devote a single line to it. The action of enzymes might be distinguished as *enzymations* to separate them from true fermentations which are such actions of bacteria as are intimately connected with, and directly dependent upon their living protoplasm itself and not upon enzymes secreted. From the recent observation of Eduard Buchner that alcoholic fermentation is not directly connected with the life of the yeast cell, it does not necessarily follow that lactic, butyric, or acetic fermentations are mere enzymations. Besides this, A. Wróblewski† has in a recent very interesting article pointed out important differences between zymase and the ordinary enzymes. The expressed juice of yeast is always *opalescent* and loses its fermentative action when filtered perfectly clear. It further soon loses its action upon mere dilution with water and also upon addition of 1½ per cent. of neutral salts. Formaldehyde, as well as sodium nitrite destroy the activity of zymase more easily than that of the true enzymes. Twenty per cent. ethyl alcohol destroys the zymase but not yet the known enzymes.

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* Moissan and Moureu, *Compt. Rend.*, Vol. 122, p. 1240.

* A natural system of poisonous actions, Chapter VI., Munich, 1893, Dr. E. Wolff, publisher.

† *Centralblatt für Physiologie*, September, 1899. He also showed that white diastase can be precipitated by saturation with sulphates, invertase can not.

ASTRONOMY IN THE FIRST HALF OF THE NINETEENTH CENTURY.

During the first half of the present century the most eminent astronomers, Karl Friedrich Gauss, Friedrich Wilhelm Bessel and Friedrich Georg Wilhelm Struve, were natives of Germany. Gauss was born in 1777 at Braunschweig; Bessel in 1784; Struve in 1793 at Altona. All three were also mathematicians, but of various mathematical ability; in Struve's case his reputation in the higher mathematics was subordinate to that as an astronomer. Gauss was one of the first mathematicians of his age, and perhaps of any time. Bessel was celebrated by his success in the most difficult problems of mathematical astronomy, as well as in the practical handling of instruments, and as a teacher of the science.

Gauss's early ability as a calculator was enough to render him conspicuous in the circle of his friends, and to stimulate his relatives, people of humble station, to make every exertion for his education. He received the degree of doctor of philosophy at Göttingen at an early age, and became professor of astronomy there. His earliest mathematical work was the 'Disquisitiones Arithmeticæ,' in which he inserted the brilliant discovery that a regular polygon of seventeen sides can be inscribed in the circle by ruler and compasses without the use of any means but those allowed by Euclid. When still a young man of twenty-four, he became widely known as an astronomer, by the rediscovery of the small planet Ceres. This had been discovered by Piazzi, and observed only a short time. After this time it was lost in the rays of the sun, and no other astronomer was able to calculate its position with sufficient accuracy to find it again, as proper formulæ were wanting in the astronomical periodicals. These formulæ Gauss possessed, and they solved the problem, and the asteroid was readily found by the results of his calculations as a star barely visible to the naked eye. As professor at Göttingen, he lived to a venerable age. Among his students was our eminent countryman, Dr. B. A. Gould. Gauss fitted up the observatory with the best instruments of the time, and his works have not yet been published in full sufficiently to content his surviving disciples.

Bessel, seven years younger, was born at Minden; and his early education was in the counting house of Messrs. Kulenkamp at Bremen. He soon found astronomy more interesting than business and became well known amongst specialists in that science. In 1814, he was made a professor and director of the observatory in the rising university of Königsberg, which soon became celebrated as the place where Bessel lived. Every effort was made to keep the young institution at the height of astronomy as then known. He lived there till 1846, when he passed away at the premature age of sixty-two, after many striking achievements, among which is especially conspicuous the first satisfactory measure of a star's distance from the solar system. He showed that 61 Cygni was more than five hundred thousand times* the sun's distance, or between forty and fifty millions of millions of miles from us.

Gauss lived till 1855 and died at the venerable age of seventy-eight, 'full of age and honors.' His younger friend, W. Struve, was the son of the head master at Altona, whose special department was philology. He received his early training in astronomy at Dorpat, where his ability as a calculator attracted the attention of Huth, then professor there of mathematics and astronomy. Huth allowed him to use the observatory freely. He received his first instructions in the use of instruments from the 'Observator' Paucker. After

* In treating this star I have used later figures than those of Bessel.

Paucker went to the college at Mitau, Struve obtained the degree of doctor of philosophy there and was soon made 'Observator' at Dorpat, where he remained a quarter of a century as professor. During his professorship at Dorpat he prepared lectures on the transit instrument, which were translated into French by a pupil, Lieut. Schyanoff, and are still an admirable textbook. Struve's ability attracted the attention of Tsar Nicholas I., and in obedience to his orders, Struve built and furnished the great central observatory at Pulkova, a suburban village near St. Petersburg. For the instruments he consulted the best mechanicians in Europe, especially the firm of Repsold of Hamburg. The observations at Pulkova were of the highest possible accuracy and were continued till Struve himself had retired from active service and had been succeeded by his son, Otto Struve, one of his most faithful students and an admirable observer. He died in 1864, and left the reputation of a scientific man, who had accomplished great results for the geography of his adopted country, and was one of the most practical astronomers of the present century.

George Biddell Airy, born in 1801, and surviving till 1892, was chiefly remarkable for the business-like routine which he introduced into the royal observatory at Greenwich, and for the example which was then set to less able astronomers of the manner in which they might conduct extensive operations connected with the vast study of the universe.

The writer considers himself not mistaken in assigning the position of astronomical science during the first half of the nineteenth century to the four philosophers mentioned in this brief paper, viz.: Gauss, Bessel, W. Struve and Airy.

TRUMAN HENRY SAFFORD.

WILLIAMS COLLEGE.

*THE ELECTRIC FISH OF THE NILE.**

THE lecture dealt almost exclusively with the formidable fish found in the rivers of North and West Africa, *Malapterurus electricus*.

Photographs were shown of the drawings upon the interior of the tomb of Ti, showing that the fish was recognized as remarkable by the Egyptians five thousand years before the Christian era. Living specimens of the fish were also displayed, these having been given to the lecturer, for the purpose of illustrating the lecture, by the authorities of the Liverpool Corporation Museum.

The structure of the electrical organ was then described. It is situated in the skin enclosing the whole body of the fish, and has a beautiful and characteristic appearance when seen in microscopic sections. Each organ consists of rows of compartments, and each compartment has slung athwart it a peculiar protoplasmic disc shaped like a peltate leaf, with a projecting stalk on its caudal side. Nerves enter each compartment, and end, according to the recent work of Ballowitz, in the stalk of each disc. By these nerves nervous impulses can reach the organ; the arrival of such impulses at the nerve terminations evokes a state of activity which is associated with the development of electromotive charges of considerable intensity constituting the organ shock. The shock is an intense current traversing the whole organ from head to tail and returning through the surroundings; it stuns small fish in the neighborhood and can be felt by man when the hand is placed near the fish, as a smart shock reaching up the arms to the shoulders.

Recent investigations made by the lecturer at Oxford in conjunction with Mr. G. J. Burch were next described. These comprised a large series of photographic records of the displacement of the mercury of a

* Abstract of a lecture before the Royal Institution of Great Britain.

capillary electrometer in consequence of the electrical disturbance in the organ which is 'the organ shock.' A number of these records were exhibited; they showed the time relations, mode of commencement and manner of subsidence of the shock, and demonstrated its similarity to the electrical changes known to exist in nervous tissue during the passage of a nervous impulse. A remarkable feature of the organ shock as distinct from the phenomena of nerve was then brought forward. The shock even when evoked by a single stimulus was shown to be rarely if ever a single one. Each effect consists of a rhythmical series of electrical changes occurring one after another in a perfectly regular manner at intervals of $\frac{1}{100}''$ to $\frac{1}{300}''$, the rate depending upon the temperature. By special experiments it was shown that this rhythmical series is due to self-excitation, each change producing an electrical current of sufficient intensity to excite the nerves of the tissue in which it was generated. It follows that only the initial member of the series need be evoked by nervous impulses descending the nerves, since the others must then ensue. The potency of the organ as a weapon to be wielded by the fish is thus enormously increased by its resemblance to a self-loading and self-discharging automatic gun. The total electromotive-force of the whole organ in a fish only eight inches long can reach the surprising maximum of 200 volts, at any rate in the case of the initial shock. The attainment of this maximum is due to the simultaneous development of perfectly similar electromotive changes in each of the two million discs of which the organ is composed. In a single disc the maximal electromotive force only amounts to from .04 to .05 volt, and since in a small nerve an electrical change of .03 to .04 volt has been observed, the large total effect is not due to any extraordinarily intense electrical disturbance in each tissue element, but to the tissue elements being so arranged that the effect in one augments those simultaneously produced in its neighbors.

Finally, the remarkable characters of the nervous connections of the organ were described. Each lateral half of the organ, although it has a million plates receiving nerve branches, is innervated by one single nerve fiber and this is the offshoot of a single giant nerve-cell situated at the cephalic end of the spinal cord. The structure of this nerve-cell was displayed by means of microscopic sections and by wax models made by G. Mann, of Oxford. As regards the nervous impulses which the fish can discharge through this nerve-cell, experimental results were described which show that the fish is incapable of sending a second nervous impulse after a preceding one until a period of $\frac{1}{10}$ second has elapsed, and that this interval is rapidly lengthened by fatigue to as much as several seconds. The inability of the central nervous system to repeat the activity of the organ obviously presents disadvantages to the use of the shock as a weapon for attack or defence, but such disadvantage is more than counterbalanced by the property of the organ alluded to in the earlier part of the lecture, viz., that of self-excitation, since a whole series of shocks continue to occur automatically in rapid succession provided that an initial one has been started by the arrival of the organ of a nervous impulse sent out from the central nerve-cell.

Francis Gotch.

SCIENTIFIC BOOKS.

The Elements of Alternating Currents. By W. S. Franklin and J. Williamson. New York, The Macmillan Company. 212 pages.

This book gives an exposition, or rather introduction into the engineering methods of investigation, that is, those methods which are used in practice to investigate the phenomena taking place in alternating circuits, and to design alternating apparatus.

The contents of the book are :

Chapters I. to IV., General Principles of Alternating Waves and Measurements.

Chapters V. to VII., Inductive Circuits, Parallel and Series Connection.

Chapters VIII. to XV., Alternators, Transformers, Synchronous Motors, Converters, Induction Motors, Transmission Lines.

The book is based on college experience and intended as a text-book for colleges, and fulfills this object admirably, better than any other book on these subjects that I know, not only by what it gives but also by what it omits. It does not give design of alternating apparatus except in a few isolated cases, which would preferably have been omitted also. The designing data and methods in the present state of the electrical industry form one of the most valuable assets of a few large manufacturing companies, and thus are practically inaccessible to the public, so that any book claiming to teach design of alternating apparatus can immediately be recognized as an intentional or unintentional fraud.

In electrical engineering, as in most branches of science, two methods of investigation exist. The *differential method* compounds the equations of the phenomena taking place in the time differential. It is the only exact method, and the method which has given broad results of universal importance in the hands of men such as Maxwell and Heavyside, but in the hands of anybody but a mathematical genius, this method is absolutely barren of results. In engineering practice to integrate the differential equations, such assumptions have to be made that ultimately the result, derived by excessive labor, applies to phantom apparatus only, as a hysteresis-less transformer, or an induction motor without self-induction, or any such monster.

In the *integral method*, the time differential and to a large extent, the time as variable has altogether disappeared, the alternating wave is represented by its quadratic mean and its phase, the E.M.F of self-induction finds its expression in a constant ohmic reactance, and even the hysteretic loop has disappeared and is represented by an angle of advance of the phase of magneto-motive force with regard to the magnetic flux.

This method is naturally an approximation only, and after the problem has been solved the results have to be discussed regarding their accuracy, and corrections applied to allow for secondary effects, as higher harmonics, etc., just as in astronomy the preliminary orbit of a comet has to be corrected for the disturbances caused by the planets.

But the integral method is the only method which is of practical utility, whether as graphical or trigometrical, or symbolic treatment in complex quantities.

Unfortunately in our colleges, usually, too much preponderance is still given to the differential method, starting from Green's theorem and leading into the nowhere, and further time wasted by spreading misinformation in the attempt to teach apparatus design, although, fortunately, a reaction is setting in now by replacing the teaching of apparatus design by that of a thorough understanding and study of the actions and internal reactions of the apparatus, and differential methods by engineering methods.

I believe, however, that these differential methods might better be dropped altogether from the curriculum of our colleges, and the time saved thereby distributed between the teaching of engineering methods, for which the above discussed book forms a very suitable text-book, and is especially intended, and differential calculus pure and simple, endeavoring in the latter to give the student a thorough understanding and intuition into the fundamental principles rather than to load his memory with a lot of useless, because immediately forgotten, formalism. There appears to me no branch of science more tedious than mathematical physics. Mathematically, it has neither the interest nor the elegance of pure mathematics, and physically, it is, with very few exceptions, barren of results.

CHAS. P. STEINMETZ.

Kinematics of Machinery. By JOHN H. BARR, M.S., M.M.E., Professor of Machine Design, in Sibley College, Cornell University. New York, Wiley & Sons. London, Chapman & Hall. 1899. 8vo., pp. v + 247, 213 illustrations, cloth. $2.50.

Professor Barr has placed within reach of the teachers of the subject a concise, yet, within its range, very complete and a very admirably planned and well-written, treatise on kinematics. The book is the outcome of a number of years experience in the methods of instruction adopted, and, privately printed, has been kept under revision until it was thought sufficiently well settled as to form and extent to justify its more general use. These years of experience in class-room work before publication insure the elimination of probably substantially all those inevitable errors of omission and of commission which mark a first edition of practically all works not thus first well pruned out in advance. The substance of the book consists of a clear and concise presentation of those main principles which find most frequent and general application in the work of the designing mechanical engineer; it is a work of application rather than an attempt at complete and purely scientific development.

The systems of treatment and application are standard with the engineer and follow the best authorities wherever practicable, and credit is frankly given to Willis, Rankine, Reuleaux, Kennedy and others, in all departments.

The discussions of fundamental concepts, methods of transmission of motion, gearing, cams, linkwork and wrapping connectors, are all excellent and the treatise gives internal evidence of preparation by an author practically as well as theoretically familiar with his subject. There is presented just such a combination of the purely scientific with the applied science of kinematics in mechanical engineering as is now in most general demand among the technical departments of our colleges and universities. At its close is appended a very useful collection of exercises and problems in illustration and application of the principles enunciated in the body of the text. Such a collection of examples has been much needed in this subject and its preparation reflects great credit upon Professor Brügel, who supplied the greater part of this division of the work, and entitles the author of the book to hardly less credit for his good judgment in making use of them.

The illustrations are well-chosen, well-made and well-printed, and the book, as a whole, is a very excellent piece of book-making and a credit alike to author and publishers.

R. H. Thurston.

Darwinism and Lamarckism, Old and New. By Frederick W. Hutton, F.R.S., etc. New York, G. P. Putnam's Sons.

This book embodies some four lectures, in which are discussed the general subject of evolution and, as indicated in the title, its Darwinian and Lamarckian aspects. Delivered at rather widely separated intervals from 1882 to 1898, they naturally lack somewhat in that continuity of thought and treatment desirable in a series of consecutive chapters. The author's apology for "adding to the already voluminous literature on Darwinism is that the subject is always advancing, and any attempt to convey that knowledge in simple language can hardly fail to do good, provided it be sufficiently clear to be understood at first reading, and sufficiently short to discourage skipping." His purpose is confessedly that of the expositor, and his treatment of the subject is generally directed to that end. At times, however, he assumes the attitude of the advocate, sparing no pains in using favorable evidence to the best possible advantage, and discounting that of an opposite character in corresponding measure.

A brief introductory chapter is devoted to the correction of certain misconceptions of Darwinism and answering objections urged against it, which, though old, are constantly being reiterated, as, for instance, the strictures of Lord Salisbury in his presidential address before the British Association in 1894. He also refers to evident advances which have taken place in biological thought within recent years, following his earlier lectures on the subject, notably the discussion of acquired characters, and to a less extent concerning social evolution. The concluding pages of this chapter he devotes to a discussion of 'The Objects of Evolution,' in which there are apparent certain teleological aspects and tendencies of a somewhat antiquated type; as, for instance, when he undertakes to show special design in the presence of gold, silver, lead, zinc, etc., which, but for the presence of man, could have had no place in the economy of nature! To say that "not only

were these made for man, but they appear to have been made as rewards for the exercise of his intellect," may satisfy the inquisitions of the author, but it may be quite an open question as to its conclusiveness to the intellect of the average Darwinian. Similarly, when he proceeds to say "There are other substances, such as the rarer elements of which no use seems ever likely to be made, except the important one of stimulating inquiry"; he can hardly be said to materially contribute to the elucidation of Darwinism or Lamarckism, *new* or *old*.

The first lecture on Darwinism, while a fair summary of the general subject, is less a critical exposition of the essentials of his subject than a comparison with the main points in the theory of Lamarck, and of limitations to the theory. The second lecture, purporting to set forth the distinctive features of the 'The New Darwinism' is, however, very unfortunate in that it strangely confuses Neo-Darwinism with those special contributions made by Gulick and Romanes, the factors of isolation and physiological selection. For example, on page 84 the author says: "The Neo-Darwinians accept Darwin's teachings, and supplement the theory of natural selection with methods of isolation, which had been either overlooked or had not been brought into sufficient prominence by Mr. Darwin." It certainly can hardly comport with clearness of exposition to confuse these contributions, valuable as they may be, with those of Wallace, Weismann and others, which have given rise to the phrase Neo-Darwinism, and established it as an integral element of recent Darwinian literature. This oversight can hardly be attributed to any lack of acquaintance with the subject, for he makes frequent reference to it. It is, however, none the less unfortunate, and renders the entire lecture more or less misleading to the class of readers to whom it is specially directed.

In the chapter devoted to 'The New Lamarckism' the author is more fortunate in this respect, properly distinguishing the principles and representatives, and their special contributions to the subject. Upon the whole the discussion is good, though, as elsewhere suggested, he at times assumes the position of the advocate rather than the expositor. And yet, strangely enough, his final summary would seem to commit him to at least a quasi indorsement of the very principles he has been so ardently criticizing. For example, on page 215 he says: "It is generally allowed that children sometimes have the habits of their parents. This may occasionally be due to imitation, but I think not always. The jerking movements of the tails of many birds, and the side movements in that of the wagtails, are probably inherited habits, for they do not appear to be of any use. * * * If habits and instincts which have certainly been acquired can be transmitted, it is probable that physical characters can be transmitted also. The best instance of this is, I think, the eyes of flatfish, already mentioned; and until some better explanation can be found, we must assume that this is a case of use-inheritance."

Speaking of the "difficulty of explaining how great changes took place in the first pelagic organisms, notwithstanding the uniformity under which they existed," the author proposes, "as a possible way out of the difficulty, that the first variations were due to different organisms assimilating different substances with their food. * * * However this may be, we know nothing capable of initiating organic changes, except the action of external forces on protoplasm." So far from discrediting Neo-Lamarckism, these conclusions, in certain of their aspects, are just such as Neo-Lamarckians have urged in support of their theory.

In a chapter devoted to the discussion of 'Darwinism in Human Affairs,' the author undertakes to point out some more or less apparent analogies between natural selection and forms of selection seen in various human institutions. While emphasizing the operation of both physical and physiological factors in social and intellectual life, he suggests a significant caution against carrying such analogies beyond the warrant of facts. "The term 'social organism' is not, in fact, a happy one, because it is misleading. What, for instance, in the organization of an animal answers to the professions of law, medicine or theology? What to prisons or reformatories?"

As a series of lectures addressed to mixed audiences, and intended as popular expositions of Darwinian doctrine, they may serve in some

measure to extend interest and prompt further inquiry. But as a serious contribution to 'the already voluminous literature on Darwinism,' their value may be seriously doubted.

CHAS. W. HARGITT.

The Growth of Cities in the Nineteenth Century: A Study in Statistics. By ADNA FERRIN WEBER, Ph.D., Deputy Commissioner of Labor Statistics of New York. (Studies in History, Economics and Public Law, Columbia University.) New York, The Macmillan Company. 1899. Pp. xvi + 495.

It is one thing to know in a general way that a certain movement is in progress, and quite another to know its causes, rate of progress and full significance. That a remarkable concentration of population in cities has taken place during the present century is well known by all; that this change in the character of the population is a momentous one is appreciated by those who give thought to the matter; but the various causes that have given rise to this movement, and the full extent and influence of the change, are known to but few if any. This information Dr. Weber has attempted, and in the main attempted successfully, to supply in the present detailed statistical study.

With a remarkable command of authorities, both foreign and American, the author carefully traces the increasing concentration of population in large cities in all the important countries of the world. Successive chapters treat of the general phases of the movement and the methods adopted for its measurement, the history and statistics of urban growth in each country separately, the causes of the concentration shown, migration as a factor, the structure of city populations as regards sex, age, nationality and occupation, birth, death and marriage rates as affecting urban growth, a comparison of the physical and moral health of cities and country, the economic, political and social effect of urban concentration upon population, and finally a consideration of certain tendencies and remedies for evils to which the growth of cities has given rise.

The work abounds in statistical tables. One cannot but admire the painstaking way in which the problem has been considered in all its phases. At the same time the very detail with which this has been done is confusing. A proper discrimination has not always been exercised. Statistical tables have been inserted wherever the slightest opportunity offered, and many are of so slight importance that they could have been omitted without loss, or their results have been better stated in the body of the text. This is especially true where they are inserted merely for the purpose of illustrating collateral facts. The same criticism applies to the bibliographical references. While the constant reference to authorities and the insertion of bibliographical notes add materially to the value of the work, many of them are entirely unnecessary or foreign to the subject matter of the book.

Generally then, this monograph is a presentation of facts and bibliographical references concerning cities that will be of the greatest assistance to all persons wishing to study almost any problem connected with urban life. Its very exhaustiveness, however, makes it difficult for the ordinary reader to discriminate between the important and unimportant, or to learn what are the really significant results of this comprehensive study.

W. F. WILLOUGHBY.

J. N. BASKETT'S 'STORY OF THE FISHES.'

A RECENT book published by the Appleton's for their 'Home Reading Series' is 'The Story of the Fishes,' by J. N. Baskett. This is an attempt to popularize the anatomy and classification of the fishes, and gives as a separate 'Talk' an interesting account of the methods of fishing. The book is attractively presented for one of its kind: its figures are unusually good and it will prove a useful aid to a beginner—who is not fastidious in matters of scientific fact. The critical reader will find much to reprehend, for there are many inaccuracies and a deal of unbased theorizing. It is scarcely necessary to consider these shortcomings in detail, although a few should be noticed. In a pictorial phylogenetic tree the type of the ganoid is given as the 'gar-pike,' intended, of course, for *Lepidosteus*, but, unfortunately, the writer inserts the picture of a *gar-fish*, *Belone*, which is a well known and highly specialized

Teleost. Of less importance is the cut of the egg-case of a shark labelled as that of the skate, together with similar slips. The introduction of such phrases as 'some fish throw their great stomachs over creatures bigger than themselves, almost as a fowler throws his nets' is hardly to be commended. In the case in question, *Chiasmodon*, the exact mode of feeding of this abyssal fish is absolutely unknown, and probably will ever remain so. But the eversion of the stomach in a star-fish-like manner is a most startling guess. It would certainly be less of a shock to morphologists if they were told that this unique specimen of a deep water fish had captured its food in the way customary with great mouthed fishes, whose distensible jaws enable them to take extraordinary mouthfuls. Perhaps the most harmful part of the book is its theorizing. Without apparently a technical grounding in his subject, the author commends to his readers many independent hypotheses, of which these, selected at random, are examples: that gill-slits were not primary; that filamentous gills, as occurring in shark embryos, are the primitive form; that the teleostean swim-bladder has 'degraded' from a lung-like condition; that 'all our fishes tended more towards being air-breathing or land-haunting creatures formerly'; that, by the evidence of (tertiary) fossils, fishes which are now tropical must have occurred in icy polar seas.

B. D.

BOOKS RECEIVED.

La nature tropicale. J. COSTANTIN. Paris, Alcan. 1899. Pp. 315.

Our Native Birds. D. LANGE. New York and London, The Macmillan Company. 1899. Pp. ix + 162. $1.00.

Elementary Astronomy. EDWARD S. HOLDEN. New York, Henry Holt & Co. 1899. Pp. xv + 446.

Lamarckiens et Darwiniens. FELIX LE DANTEC. Paris, Alcan. 1899. Pp. 191. 2 fr. 50.

Analyse microchimique et spectroscopique. E. POZZI-ESCOT. Paris, Gauthier-Villars. 1899. Pp. 192. 2 fr. 50.

Report of the Proceedings of the Seventh Annual Meeting for the Promotion of Engineering Education, Vol. VII. Published by the Society. 1899. Pp. xxii + 193.

SCIENTIFIC JOURNALS AND ARTICLES.

WE regret to learn that *Natural Science* is compelled to suspend publication. It will be remembered that this was threatened last year but was temporarily averted by a change of editors and publishers. *Natural Science*, while maintaining a high standard, has been, perhaps, the most readable of the scientific journals, and it seems unfortunate that there should not be sufficient financial support to warrant its continuation. There is, however, no scientific journal in the world that is self-supporting, in the sense of paying editors and contributors for their work at what would be its market value in other directions of activity. This, of course, also holds for universities, museums, etc., and there appears to be no reason why scientific journals should not be endowed or subsidized, as is necessary in the case of other scientific institutions. Under the heading 'Eliminated' *Natural Science* takes leave in the following words:

> It is one of the conditions of continued vigorous activity on an organism's part that income be at least equal to expenditure, and the same is true of journals. To try to sustain the activity when the aforesaid condition is not fulfilled is not uninteresting, but there are limits to the possibility of continuing it. We regret to say that we have reached these limits as regards *Natural Science*, of which this is the last number, so far as we are concerned. In spite of generous support from many during the past year, and our own endeavors in publishing and editing, the journal has not reached that measure of success which would seem to us to warrant another year's experiment. We make our bow, then, to the process of natural elimination.

The Journal of School Geography, which has hitherto been published as well as edited by Professor Richard E. Dodge, of the Teachers College, Columbia University, will hereafter be published by the J. L. Hammett Company, of Boston, Mass., and New York City. This change in the business management involves no change in the editorial management or policy.

SOCIETIES AND ACADEMIES.

THE NEBRASKA ACADEMY OF SCIENCES.

THE Academy held its Tenth Annual Meeting on December 1st and 2d in the botanical lec-

ture room of the State University at Lincoln. At this meeting the following programme was carried out:

FRIDAY, DECEMBER 1ST, 2 P. M.

Address by the President—The Present Status of Meteoric Astronomy, by G. D. Swezey.

Report on the Initial Work of the State Geological Survey, by E. H. Barbour.

Some Phases of the Dakota Cretaceous in Nebraska, by Chas. N. Gould.

Geology of Saunders, Lancaster and Gage Counties, by Cassius A. Fisher.

On the Origin of Gneiss, by C. H. Gordon.

Preliminary Survey of the Mammals of Nebraska, by R. H. Wolcott.

Notes on a Bibliography of the Zoology of Nebraska, by H. B. Ward.

A Genus of European Flies hitherto not Reported in North America, by W. D. Hunter.

The Tiger Beetles of Nebraska, by L. Bruner.

Davenport's Statistical Methods, by Ellery W. Davis.

A Rearrangement of the Phycomycetous Fungi, by Chas. E. Bessey.

Some Movements of Plants, by Wm. Cleburne.

SATURDAY, DECEMBER 2D, 9 A. M.

New Fossils from Nebraska and Wyoming, by E. H. Barbour.

Method of Collecting Fossils for the Nebraska State Survey, by Carrie A. Barbour.

A Simple Substitute for the Birge Net, by Charles Fordyce.

Methods of Plankton Measurement and their Comparative Value, by H. B. Ward.

A Plan for the Coöperative Study of the Fresh Water Fauna of Nebraska, by H. B. Ward.

A Few Suggestions concerning Collecting Nets, by R. H. Wolcott.

Pressure and Freezing Tests of the Building Stone of Southeastern Nebraska, by W. H. H. Moore.

A Brief Report on the Growth of Children in Omaha, by Wm. W. Hastings.

A New Nematode Disease of Strawberries in America, by Ernst A. Bessey.

Cold Waves, by G. A. Loveland.

Scarcity of Aquatic Life in Nebraska the Past Summer, by R. H. Wolcott.

Glacial Grooves in Cass County, Nebraska, by E. H. Barbour.

The officers elected for the ensuing year were:

President, Dr. H. Gifford, Omaha, Nebr.

Vice-President, Ellery W. Davis, Lincoln, Nebr.

Secretary and Custodian, Professor L. Bruner, Lincoln, Nebr.

Treasurer, G. A. Loveland, U. S. Weather Dept., Lincoln, Nebr.

Board of Directors: Professor J. H. Powers, of Doane College, Crete, Nebr.; Professor Charles Fordyce, University Place, Nebr.; Acting Chancellor C. E. Bessey, Lincoln, Nebr., and Dr. A. S. von Mansfelde, Ashland, Nebr.

On the evening of December 1st the members of the Academy and the public in general had the privilege of listening to a very interesting lecture entitled 'Observations of a Naturalist in Ecuador,' by August Rimbach, of the Department of Botany, University of Nebraska, at the close of which the members of the Academy sat down to a banquet, at which a pleasant social time was had.

LAWRENCE BRUNER,
Secretary.

WASHINGTON CHEMICAL SOCIETY.

THE regular meeting was held November 9, 1899.

The first paper of the evening was read by Dr. H. C. Bolton and was entitled, 'Reminiscences of Bunsen and the Heidelberg Laboratory, 1863–65,' and was printed in SCIENCE of December 15th.

The second paper of the evening was read by Dr. H. C. Bolton and was entitled, 'Chapters on the History of the Thermometer, I., The Open Air-Thermoscope of Galileo.'

The primitive form of the thermometer was invented about the year 1595 by Galileo; this is proved by extant letters addressed to him by his pupil and friend Sagredo. The instrument was an open air-thermoscope of the inverted type and was early applied to meteorological observations, to testing the temperature of fever patients and to noting temperatures of freezing mixtures.

The very common statement that the thermometer was the invention of C. Drebbel, of Holland, has no basis of fact, as shown by his own publications, copies of which were exhibited by the speaker.

The third paper of the evening was read by

Dr. F. W. Clarke and was entitled, 'The Action of Ammonium Chlorid upon certain Silicates,' by F. W. Clarke and George Steiger.

The authors described a series of experiments in which various silicates were heated in a sealed tube to 350° C. with dry ammonium chlorid. After leaching out the contents of the tube with water it was found that alkalies were removed as chlorids and replaced by ammonia, analcite and leucite are thus transformed into an ammonium leucite:

$$NH_4Al.Si_2O_6$$

which is perfectly stable at 300° and only begins to decompose when heated in the open air to 350°.

Some eight other silicates were given preliminary study and the reaction was found to be fairly general. The product from natrolite contained 8.3 per cent. of ammonia and other zeolites took up from four to six per cent. The investigation is to be continued.

The fourth paper was read by Dr. F. K. Cameron and was entitled, 'Hydrochloric Acid and Aqueous Phenol,' by F. K. Cameron and J. A. Emory.

The authors determined the freezing-point curve for hydrochloric acid solutions, saturated with respect to phenol. Each independently determined the concentrations of the various solutions and their freezing-points for intercomparison. The curve was found to be a straight line, parallel to the curve for water and hydrochloric acid alone, from which it would seem that the solubility of phenol is practically constant through the range of temperature involved, and the lowering of the freezing-point of the solvent is a purely additive effect of the two solutes.

The fifth paper was read by Dr. F. K. Cameron and was entitled, 'The System Water, Hydrochloric Acid and Phenol,' by F. K. Cameron and W. H. Krug.

On lowering the temperature of the system, solid phenol separates. But if the initial mass of water be relatively large its concentration with respect to hydrochloric acid is practically unaffected, while the solid phenol is separating and consequently the temperature of the phenol remains very constant. The freezing-point curve for phenol in contact with aqueous solutions of hydrochloric acid of various concentrations was determined. Its practical value for a rapid determination of the approximate strength of hydrochloric acid solutions was indicated.

WILLIAM H. KRUG,
Secretary.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the New York Section of the American Chemical Society was held on Friday evening, the 5th inst., at the Chemists' Club, and was well attended, over sixty members and their friends being present. Dr. C. F. McKenna occupied the chair, calling the meeting to order at 8:30 p. m.

After electing four delegates to represent the Section in the Council, the following papers were read:

(1) 'The Importance and Trend of Recent Work on the Chemistry of Life and the Products of Life,' by Jerome Alexander.

(2) 'A Preliminary Study of the Cobalti-Cyanides,' by E. H. Miller and J. A. Mathews.

(3) 'The Chemistry of Corn Oil. First Paper: Determination of the Constants,' by Herman T. Vulté and Harriet W. Gibson.

(4) 'A Practical Electric Furnace,' by A. J. Rossi.

Mr. Rossi exhibited a practical and easily constructed electric furnace with which he has prepared some very rich Titanium alloys, a specimen of which was exhibited with an invitation to break off pieces as samples. Although a sledge hammer was supplied no samples were taken. Arrangements are progressing toward the preparation of these alloys on a large scale for the steel trade.

DURAND WOODMAN,
Secretary.

TORREY BOTANICAL CLUB.

AT the meeting on November 29th, the scientific program consisted of a paper by Dr. C. C. Curtis, on Seaweeds, with lantern views illustrating the chief families and with a condensed summary of the modes of reproduction and other characteristics of each. Dr. Curtis also gave brief directions respecting methods of collecting and preserving the marine algæ, urging the collector to make microscopic study of all

forms, and pointing out the great need of further observation to clear up doubtful points in their reproductive processes.

President Brown exhibited specimens found by Dr. Meredith at Danville, Pa., of *Ajuga Genevensis* and of *Hieracium Pilosella.* The first had been observed on ballast in New York City, but not the latter.

On December 12th, the scientific program was opened by a paper by Dr. L. M. Underwood 'On the Genera of the Schizaeaceae.'

Dr. Underwood explained the peculiar detriscence of the sporangium by which this order of ferns is distinguished, illustrating with figures, and then sketching the history of the order. Linnæus put its species under Acrostichum; Richard was the first to begin segregation, erecting in 1792, the genus *Lophidium.* In 1703, *Schizaea* was founded by Smith, on a South African plant common through the Transvaal region, quite closely similar to our own species of New Jersey. Wallich founded another genus, *Actinostachys*, in 1822, on an East Indian form. Dr. Underwood considered these three genera to be valid, though recent German systematists, as Prantl, have not recognized them.

Swartz constituted another genus in 1800, *Mohria*, from Cape Colony, of which only one species is known. *Lygodium*, our best known genus, was established by Swartz in 1800, and includes one well known Atlantic species, *L. palmatum*, the climbing-fern.

Several other genera, as *Aneimia* and *Trochopteris*, were discussed, with remarks on principal species. About 90 species of the order have been published, largely American and tropical, especially the abundant Brazilian forms of Aneimia and allies.

Professor Lloyd suggested the interest attaching to Trochopteris as possibly a very primitive fern.

Dr. Underwood said it is sparsely represented from Brazilian collections, but perhaps because of its small size and habit of growth close to the ground, the largest specimen known being only three inches in diameter.

The second paper was by Dr. D. T. MacDougal, 'Studies on Hexalectris.' This rare southern orchid is of great interest on account of its supposed near relationship to Corallorhiza, which develops short coralloid undergrowths without roots, but producing a mycorhiza and sending out hyphæ into the soil. Material of Hexalectris from Alabama although possessed of somewhat similar coralloid growths, was found to contain no fungi, and to be without apparent adaption to growth by mycorhiza. No one seems to have seen seen the roots of this plant.

The third paper was by Dr. N. L. Britton, 'Notes on Species of *Crataegus.*'

Dr. Britton exhibited and discussed 34 species of the northeastern United States and remarked upon the great need of persistent field study in determining this genus. One must have flowers, mature leaves and mature fruit from any individual bush before he can begin to find its relationship to any other form. The most difficult part of the genus is perhaps the *C. tomentosa* group. Many southern species have recently been found to extend their range into Virginia, as *C. Chapmani*, *C. Carolina*, etc.; and others in Missouri, as *C. berberifolia.* The identity of the original of *C. coccinea* of Linnæus proves to have a special local interest. Linnæus seems to have had, as often, no specimen before him, but based his description on a plate of Plukenet (and another of Ray). Few herbarium specimens correspond well to the figure, which answers only to leaves of a shrub collected twice near New York, once by Mr. E. P. Bicknell along the Harlem River and once by the late Professor E. H. Day on Persimmon Island near New Rochelle, New York. The leaves bear a remarkable resemblance to those of *Betula nigra.* Search for similar specimens near New York should be made; the leaves are longer and with blunter, shallower lobes than in the commonly-received *C. coccinea.*

Dr. Britton is endeavoring to get together at the Botanic Garden a collection of these species, and now has over a dozen; but the wild stock is very difficult to grow and is impatient of transplanting. Most gardeners graft or grow from seed.

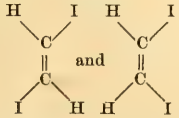
After discussion by Dr. Rydberg, President Brown and others, the Club adjourned.

EDWARD S. BURGESS,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis of December 4, 1899, the following subjects were presented:

Dr. Edward H. Keiser talked informally on Some Derivatives of Acetylene, exhibiting specimens of the new liquid acetylene iodide discovered by him in January, 1899. He described the methods of making the compound, and gave an account of its chief physical and chemical properties. The liquid acetylene diiodide solidifies at —21° C. and boils at 185°. It has the percentage composition and molecular weight represented by the formula $C_2H_2I_2$, and is isomeric with the well known solid acetylene diiodide. The speaker announced the discovery of a new method of making the liquid acetylene diiodide, namely, by heating the solid compound to 260° in a sealed tube. The solid compound is thereby partially converted into the liquid compound. Similarly, if the pure liquid diiodide is heated to 260° in a sealed tube, on cooling down, the liquid will be found to have been partially converted into the solid compound. All the facts known indicate that these two iodides of acetylene are stereoisomers, and that their configuration must be represented by the stereometric formulas:



Since Dr. Keiser has found that the solid acetylene diiodide can be converted into fumaric acid, it follows that the first of the two formulas represents the solid acetylene diiodide and the second one the liquid diiodide. Further experiments upon these compounds are under way, and the attempt will be made to convert the liquid diiodide into maleic acid.

Dr. L. Bremer demonstrated some tests for glucose by means of anilin dyes, showing that nearly all of the 'alkaline' anilin dyes, when rendered basic by the addition of sodium hydrate, become decolorized, or have their color greatly modified, on heating, in case glucose is presented. The reactions shown were especially pretty in the case of methylene blue and safranine.

Professor Nipher announced that he had nearly completed preparations for the measurment of wind pressures on the sides of the main building of Washington University. The pressures are to be measured at various points along the west end of the building, having a width of about 50 feet, and along the north front, which is something over 200 feet in length. Simultaneous measurements of wind pressure and wind velocity and direction will be made. The method used is that tested by him on the trains of the Illinois Central Railroad during the summer of 1897. The method was described in No. 1, Vol. VIII., of the Transaction of the Academy of Science of St. Louis. An invitation was extended to members to visit the University and inspect the apparatus.

Professor H. Aug. Hunicke spoke briefly on some observations which he had recently made on the boiling temperature of hydrocarbons, from which it appeared that when T is the boiling temperature (absolute scale), ς is radius of gyration of the molecule, and a is a constant, then $T^2 = a\varsigma$. This holds for the entire series of saturated hydrocarbons, including all isomers. The speaker stated that his observations had not yet been extended beyond the series indicated.

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

DARK LIGHTNING.

MAY I be allowed to make some comment, on the interesting article by Professor Wood on 'Dark Lightning.' He is mistaken in supposing that my results on the same subject have only appeared in a photographic journal. The first announcement was a note read before the Physical Society of London on June 22, 1889, which was published in the *Electrician*, the *Philosophical Magazine* and the *Proceedings* of the Society.

Further details were the subject of a paper read at the Newcastle meeting of the British Association in August of the same year, and an abstract of it appears on page 507 of the Annual Report. Since then there have been numerous

references in the reports of the British Association Committee on Meteorological Photography and other places.

So long ago as August, 1889, I had shown conclusive proofs that the phenomenon was not due to any difference in the refrangibility of the light of the spark and that of the reversing light. I showed that the light of the sparks themselves could effect reversal of the images of others. Perhaps I may be allowed to quote from the paper.

"A plate was then exposed in the camera to a series of sparks, then to the direct light of more sparks without the interposition of the lens, and finally to a second set of sparks. The images of the first set show reversal while those of the second are direct.

"Next a plate was exposed to one set of sparks and without removing it from the camera the light of some more was diffused by holding a sheet of ground glass in front of the lens. Finally a second set of sparks was photographed. The results were similar."

These two experiments enabled me to reproduce the phenomenon of a bright flash crossing a dark one, and the reversal of one flash by the diffused glare of another.

In the second place plates were exposed to a number of spark images and then to a tolerably pure spectrum. The result was reversal in all parts, and by varying the length of exposure to the spectrum it was shown that the reversing power was simply proportional to the direct actinic power, maximum reversal occurring when the direct actinic effect of the reversing light was equal to that of the spark images. I was, therefore, entitled to sum up thus:

"Differences of refrangibility, therefore, do not seem to lie at the root of the matter. Neither can a difference of intensity be the cause of the reversal, for the less intense the light of the spark the more easily is its image inverted. It seems to me that the extreme shortness of the exposure to the electric spark may be the explanation."

A similar conclusion was indicated by the fact that the image of a spark very much out of focus did not lose the property of reversibility.

But how were we to account for the experiments showing that the spark images could be reversed by the light from other sparks? Was it possible that objects illuminated by these reversing sparks (card, objects in the room or ground glass) reflected or modified the light sufficiently to change its action on the photographic film?

I also tried to imitate the phenomena by brief exposure to other luminous objects trying in turn slits illuminated by gas, lime-light, magnesium and sunlight. I had no arc lamp available then. Here Professor Wood has done better, my results were nil and I congratulate him on his success.

However I should like to suggest that it is just possible that light from a source whose excitement is electrical *may* differ from other kinds of light in some manner at present unknown and that it is not safe to regard it as proved that the time element is the only one involved until the phenomena have been repeated without employing electricity at all.

For ten years the facts have been before the world. They were partly verified eight or nine years ago by Mr. Shelford Bidwell and it is highly satisfactory to find them verified again in so many particulars, by another physicist who has reached the same conclusions by means of somewhat different experiments.

ARTHUR W. CLAYDEN.

ROYAL ALBERT MEMORIAL COLLEGE,
EXETER.

SOCIOLOGY AND PSYCHOLOGY.

TO THE EDITOR OF SCIENCE: The relation of sociology to psychology suggested by Professor F. H. Giddings in his article, 'Exact Methods in Sociology' (*Popular Science Monthly*, December, 1899), is so misleading that it demands a word of protest from the psychologist. We must regard it as a capital mistake when any sociologist tries to make his science a means of measuring psychological quantity. Thus, when Professor Giddings (p. 155) would measure the 'intelligence' of societies by comparative statistics of literacy, for instance, he overlooks such facts as these: that mere reading, like talking, signifies little—the main point being what is read, whether Hegel or the yellow journal—and that how much is understood

must be measured. Some exceptional reader in a community may exceed in intelligence the sum of intelligence of all other readers, and even some illiterate may go beyond a number of literates. Hence only by the special study of individuals, and adding the results, can the sum total of intelligence for any community be found. But this is the task of psychology, not sociology, whose field is objective fact, social actualities like illiteracy, crime, etc., and their concomitant variations. Sociology can determine how many people read, and what they read, and the concomitant variation between the circulation of yellow journals and increase of crime; but it cannot measure the intelligence or the emotion implied, for the psychical illumination of social phenomena can come only from psychology.

HIRAM M. STANLEY.

LAKE FOREST, ILL., December 2, 1899.

NOTES ON INORGANIC CHEMISTRY.

A PECULIAR interest attaches to ammonium cyanate from the fact that it was the spontaneous conversion of this salt into urea, which first bridged over the gulf between the inorganic and organic, and in the hands of Wöhler gave the great impetus to the study of organic chemistry. Owing to its instability it has been very difficult to prepare ammonium cyanate in a pure condition. It is shown, however, in the *Proceedings* of the Chemical Society (London), by J. Walker and J. K. Wood, that the substance may be readily formed by mixing the cooled solutions of ammonia and cyanic acid in ether. It is also formed when the vapors of ammonia and cyanic acid are brought into contact, provided the reacting gases are sufficiently diluted with some indifferent gas. The transformation of solid ammonium cyanate into urea is facilitated by heat and very greatly accelerated by presence of moisture.

IN the same Journal, G. Dean describes a new series of atomic weight determinations of nitrogen. They are peculiar in their use of silver cyanid as the salt analyzed. The other atomic weights involved are those of potassium and bromin, hence the accurately determined Stas figures were available. The value found was $N = 14.031$ which is somewhat lower than the weight accepted by Clarke 14.04, and that by Richards 14.045. ($O = 16$).

IN a recent number of the *Comptes Rendus*, Moissan has described the formation of ozone by the decomposition of water by fluorin. If the temperature of the water into which the fluorin is led, is kept at or below zero, it is possible to get over 14 per cent. ozone (by volume) in the gas over the water. Moissan points out the possible practical application of this method, for though the electrolytic production of fluorin from hydrofluoric acid is still a rather difficult operation, it is not an expensive one. The ozone formed in this process has the advantage of being completely free from the oxides of nitrogen.

OF late years several explosions have taken place in factories where aluminum-bronze powder is ground. Investigations as to the cause of these explosions have been made by Stockmeier, and are reprinted in the *Chemical News*. The powder is perfectly stable, but its mixture with potassium chlorate will detonate even by rubbing. Bronze in contact with water decomposes it forming hydrogen, and it is to the presence of the hydrogen that explosions are probably due. The powder is hygroscopic and the dry powder can absorb 1.4 per cent. moisture from the atmosphere. Then in grinding up five or six kilos of bronze powder there could be moisture enough present to generate forty to fifty liters of hydrogen. A series of precautionary rules is proposed, the most important of which require dryness and absence of dust in the air about the grinding machine.

PROFESSOR E. T. ALLEN of the Missouri School of Mines calls attention in the *Chemical News* to a curious case of corrosion of gold plated weights which had been put away for the three summer months in a safe. The weights were covered with a white substance which proved to contain zinc and to be largely organic. The suggestion is made that the corrosion was caused by mould, the gold plating being, perhaps, not completely impervious, and the most positive metal, zinc, being removed from the brass. It appears to be well established now that certain hard waters have the property of dissolving the

zinc out of brass. A more important question is raised by Professor Allen, as to whether, under ordinary working conditions in the laboratory, gold plated weights are preferable to brass weights.

J. L. H.

BEEREN EILAND.*

THE Swedish Arctic Expedition of 1898, under the leadership of Professor A. G. Nathorst, spent a week on Beeren Eiland, mapped it on a scale of 1 : 50,000, and made numerous observations on its natural history. Chief among these were the geological researches which proved a prehistoric local glaciation, and by means of fossils showed the presence of rocks of three systems: Silurian, Middle Carboniferous, and Trias, previously unknown on the island. These discoveries led to another expedition to Beeren Eiland during the past summer. The expenses were borne by the Vega Stipend of the Swedish Geographical Society, the Lars Hierta Memorial Fund, and various private individuals. The leader was the geologist, J. Gunnar Andersson of Upsala, who had accompanied Professor Nathorst; the other scientific members were C. A. Forsberg, cartographer and meteorologist, and G. Swenander, zoologist and botanist. The expedition stayed on Beeren Eiland from June 22d to August 19th, and accomplished the following work:

The whole island was mapped in greater detail, and a special map, on a scale of 1:5000, was made of Rysshamn, where the expedition had its headquarters.

From June 25th to August 16th complete meteorological observations were taken twice a day, as well as continuous observations by a self-registering barometer and thermometer. Eight series of observations were made on the tides, each series extending over from 8 to 51 hours, during which time the height of the water at intervals of half an hour was marked off on a section.

The botanist collected all the phanerogams previously found on the island, as well as *Koenigia islandica*, hitherto unrecorded. Exhaustive collections were also made of the lower plants, including the algæ of red and green snow. To investigate the influence on plant-growth of the continuous light of an Arctic summer, three series of cultivation experiments were carried out, as follows: First, in five places of nearly the same longitude, but at a distance of about 3 or 4 degrees of latitude from one another—namely, Svalöf, in Scania, Ultuna, near Upsila, Luleå, Tromsö, and Beeren Eiland—barley taken from the same sample was grown in soil from the same place. Only the climatic conditions, and especially those of light, were different in the different stations; thus there were completely dark nights in Scania, complete light the whole 24 hours on Beeren Eiland, with intermediate conditions at the intervening places. The material from the Scandinavian stations has not yet been brought in, so that the results of this interesting experiment are still awaited. Secondly, on open land at the Beeren Eiland station there were cultivated two precisely similar series of Arctic plants, of which one series stood in continual light, while the other was kept in complete darkness each night (8 p. m. to 8 a. m.). During the period of the experiment the development of these plants did not proceed very far, but the series kept in the light was obviously the more sturdy. The third experiment consisted in the cultivation, on a hot-bed, of a score of common Scandinavian plants. These also were in two similar series, one kept in the light, the other darkened by night. The experiment succeeded with 18, and of these 16 were clearly more sturdy in the light series, some of them yielding examples half as large again as those in the darkened series.

To the list of the island's fauna were added two birds: the Skua (*Lestris pomatorhina*) and the Spitzbergen form of *Mormon articus*. *Salmo alpinus* was found in a lake. Special attention was paid to the insects, which on isolated oceanic islands are of much interest to the student of distribution. Holmgren, the only entomologist who had previously visited Beeren Eiland, found there in 1868 only 9 species of Diptera and 1 Hymenopteron. The Swedish expedition has brought back a large collection of Diptera, not yet worked through, 4 Hymenoptera, 1 Neuropteron and 2 Coleoptera. Holmgren found only 2 Acarids; the present explorers have at least 10.

* From *Natural Science.*

The chief object of the expedition was a detailed geological investigation of the island. This has been successfully carried out with valuable results. A large collection of fossil plants from the coal-bearing series has been made; numerous fossils have been collected from all the marine strata, especially from the Trias. A geological map of the whole island has been constructed. The stratigraphy and tectonic geology of the whole island has been worked out, and there have been discovered in the southern part of the island a series of dislocations of Carboniferous age, which explains the topography of the hilly regions and the varying development of the Carboniferous system at various points.

Mr. Gunnar Andersson and his companions are to be congratulated on the amount of solid work they have accomplished, and we look forward to the publication of the detailed results with much interest. It should be mentioned that the proprietor of Beeren Eiland, Mr. Lerner (who happens to be a German), has helped the expedition, and hopes to welcome it back in some future year.

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*THE STOCKHOLM FISHERIES CONFERENCE.**

IT is too soon yet to say that the International Fisheries Conference, which met at Stockholm this summer, will have any practical outcome; but the report of its proceedings suggests a general plan of investigations as regards hydrographical and biological work which, if properly organized and supported, should certainly be productive of useful and valuable results. The object of her Majesty's Government in deciding to take part in the conference may be best summarized in the language of the instructions given to Sir John Murray, one of the British delegates:

"You should propose that the scientific investigations shall be accompanied by a practical *exposé* of the steps to be taken in order to bring the exercise of sea-fishing more in accord with the natural conditions regulating the growth and increase of the fish, and thus permanently increase the supply of fish in the markets of the countries adjoining the North Sea.

"In making this proposal, which you should do at the outset, you should make it clear that the principal object which her Majesty's Government have in view, in directing you to take part in the conference, is to secure a careful inquiry into the effect of present methods of fishing in the North Sea, and you should give every assistance in promoting a scheme for determining whether protection against overfishing is needed, and, if so, where, when and how such protection should be given."

The countries taking part in the conference were Great Britain, Germany, Russia, Denmark, Norway, Sweden and Holland. The representatives of the United Kingdom were Sir John Murray, of the *Challenger* Expedition, Mr. W. Archer, Chief Inspector of Fisheries, and Professor W. D'Arcy Thompson, of Dundee University, while Dr. Nansen was one of the delegates from Norway.

Most persons who have given a thought to the subject must be convinced that a rational treatment of fishery questions should be based on scientific inquiry; and in the opinion of the conference the best way of arriving at satisfactory results in this direction is by international coöperation. The scheme of investigations, having for its ultimate object the promotion and improvement of fisheries through international agreements, which the conference resolved to recommend to the Governments of the countries concerned, embraces a program for hydrographical and biological work in the northern parts of the Atlantic Ocean, the North Sea, and the Baltic and adjoining seas. These investigations, it is added, should be carried out for a period of at least five years.

Among the hydrographical researches proposed are: The distinction of the different water-strata, according to their geographical distribution, their depths, their temperature, salinity, gas-contents, plankton, and currents, in order to find the fundamental principles not only for the determination of the external conditions of the useful marine animals, but also for weather forecasts for extended periods in the interests of agriculture. The biological work would include the determination of the topographical and bathymetrical distribution of eggs and larvæ of marine economic fishes; the continued investigation of the life, history and conditions of life of young fishes of economic species in their post-larval stages, with special reference to their local dis-

* From the London *Times*.

tribution; the systematic observation of mature marketable fishes with reference to their local varieties and migrations, their conditions of life, nourishment and natural enemies; observations on the occurrence and nature of fish food at the bottom, the surface, and intermediate waters down to the depths of at least 600 meters; and determinations of periodic variations in the occurrence, abundance and average size of economic fishes and the causes of the same. These are briefly some of the principal points mentioned in the program of work recommended.

To carry out these investigations on a basis of international coöperation, and in order to ensure uniformity of method, it is proposed to create an international council with a central bureau and a central laboratory at an estimated annual cost, including salaries of staff, of £4,800, to be divided among the Governments concerned. No place is mentioned for this central bureau, which, however, should be conveniently situated for hydrographical and biological researches. It is considered desirable that the work should begin on May 1, 1901.

DEVONIAN FISHES FOR THE AMERICAN MUSEUM.

THROUGH a generous gift of a Trustee, Mr. William E. Dodge, the American Museum of Natural History has recently purchased the Jay Terrell collection of fossil fishes of Ohio—forms which from their great size and formidable dentition have long been known as among the most interesting as well as the rarest of fossil vertebrates. The present collection is the result of over six years' energetic and skillful field work. It is the fourth collection which Mr. Terrell has formed: the first was secured by the late Professor J. S. Newberry, and is now preserved at Columbia University; the second is at Harvard, and the third is at Oberlin. Of popular interest in connection with the present purchase is the fact that material is now at hand for exhibiting as a single specimen the parts of the gigantic Placoderm Dinichthys Terrelli. The specimen is unusually complete and appears to be the largest hitherto secured—a jaw alone measuring nearly two feet in length. Much of the collection is of exceptional importance: it includes associated head plates of Titanichthys, jaws of Diplognathus, and immature jaws of Mylostoma.

BASHFORD DEAN.

THE SPELLING OF 'PUERTO RICO.'

IF anything further were needed to determine the proper spelling of the name of our new West Indian Island possession, it has been supplied in a decision of the President of the United States himself. Through Secretary of State Hay, under date of December 16, 1899, the President declares in favor of the spelling *Puerto* Rico, basing his decision more especially on the fact that this is the spelling followed by the people of the island. He was doubtful mindful also, however, that *Puerto* is good Spanish for port just as *Rico* is Spanish for rich. He sustains the decision of the U. S. Board on Geographic Names, made some years ago and since followed by some of the Government departments but not by others.

W. F. MORSELL.

SCIENTIFIC NOTES AND NEWS.

AS SCIENCE goes to press a number of our most important scientific societies are holding meetings in New Haven, Washington, New York and Chicago. The American Society of Naturalists meets at New Haven, together with the societies more or less closely affiliated with it, namely, The American Morphological Society, The Association of American Anatomists, The American Physiological Society, The American Psychological Society, The Society for Plant Morphology and Physiology, The American Folk-lore Society, Section H, Anthropology, of the American Association. A Bacteriological Society will at the same time be organized. The American Chemical Society also meets at New Haven. Western naturalists are organizing a society at Chicago. The Geological Society of America is meeting at Washington and the American Mathematical and Physical Societies at New York. We hope to publish in subsequent numbers full accounts of the meetings of these societies.

PROFESSOR WILLIAM HARKNESS, astronomical director of the U. S. Naval Observatory,

was retired as rear admiral on December 17th, on reaching the age of sixty years. Professor Stinson Joseph Brown has been appointed to the position. He was born at Hammondsport, N. Y., in 1854, and graduated from the Naval Academy in 1876. He was employed in the U. S. Coast and Geodetic Survey and in 1881 obtained by competitive examination a professorship of mathematics in the Navy.

M. LEMOINE has been elected a member of the Section of Chemistry of the Paris Academy of Sciences in the room of the late M. Friedel. M. Lemoine received 32 of the 57 votes cast.

PROFESSOR JOSIAH ROYCE of Harvard University, sailed from New York on December 27th, in order to give his second course of Gifford Lectures at the University of Aberdeen. Professor Royce will also lecture at Glasgow and Oxford. He will return to Cambridge early in February.

PROFESSOR ALBERT P. BRIGHAM, of Colgate University, who has been abroad with his family for ten months, has returned, and will resume his college duties with the new term. During his absence, Professor Brigham has traveled extensively in England, Scotland, Germany, and Switzerland, and has spent a number of weeks in study and literary work at Oxford and Munich.

MR. ARTHUR HENRY SAVAGE LANDOR, the explorer, arrived in New York from England on December 23d.

AMONG the passengers by the mail steamer *Bakana* for the west coast of Africa on December 8th were three medical men, Dr. Christopher, Dr. Stephens, and Mr. A. Pickels, bound for Sierra Leone and Lagos. They are going out at the expense of the Colonial Office, having been selected by the Royal Society, and their work will be carried on under the auspices of the Liverpool School for Tropical Diseases.

DRS. WILLIAM OSLER and Howard Kelly, of Baltimore, have been elected honorary members of the Royal Academy of Medicine of Ireland.

THE Royal Geographical Society London has elected the following honorary corresponding members: Captain Meliton Carbajal (president of the Peruvian Geographical Society), Professor A. Bertrand (professor of topography and engineering in the University of Santiago, Chile), and Señor D. Samuel A. Lafone Quevedo, a distinguished geographer and ethnologist of Buenos Ayres.

MR. BAILEY WILLIS of the United States Geological Survey, addressed the members of the Geological Club of the University of Chicago on November 29th, on 'A Pacific Atlantis.'

THE centennial anniversary of the birth of Joseph Henry, was celebrated at his birthplace, Albany, on December 16th, at a joint meeting of the Albany Institute and the Albany Historical and Art Society. The exercises were held at the Albany Academy where Henry taught for many years before going to Princeton and the Smithsonian Institution.

THE death is announced of Dr. Birsch-Hirschfeld, professor of pathology in the University of Leipzig, at the age of 57 years.

THE death is also announced of Dr. John Frederick Hodges, professor of agriculture and lecturer on medical jurisprudence in Queen's College, Belfast. Dr. Hodges was the author of books on chemistry and agriculture and was perhaps the oldest member of the Chemical Society of London, having been elected a fellow in 1844, three years after the formation of the Society.

DR. ARTHUR COWELL STARK was killed by the explosion of a shell on November 18th at Ladysmith, where he was serving as a volunteer on the medical staff. Dr. Stark was an authority on South African ornithology and had just completed the first volume of a work on South African birds for Mr. W. L. Sclater's Fauna of South Africa.

WE regret also to record the death of Mr. N. E. Green, an artist who accomplished important scientific work in making astronomical drawings. He was a past president of the British Astronomical Association.

THE American Museum of Natural History has secured through the generosity of President Jesup the second part of the Cope collection of fishes, amphibia and reptiles. It will be remembered that by the will of the late Professor

Cope the proceeds of the sale form an endowment fund for the Philadelphia Academy of Natural Sciences.

ACCORDING to a notice in the New York *Commercial Advertiser* of December 16th, the Peabody Museum at New Haven has been enriched by a valuable accession to the anthropological collections. The addition consists of Mexican and Guatemalan antiquities, about 350 pieces in all, which were brought from but two localities—Sempoala, state of Vera Cruz, and Tacana, Guatemala.

THE Hon. Walter Rothschild, M.P., treasurer to the Middlesex Hospital, has sent a donation of £100 towards the maintenance of the new research laboratories for the investigation of the cause of cancer in connection with the new wing for female cancer patients of that institution.

MR. ANDREW CARNEGIE has offered $50,000 for a public library in Oil City, Pa., on the conditions that a site be donated, and that the city appropriate $3,000 annually for the library's support.

IT is stated in *Natural Science* that the Mortimer Museum of Antiquities at Driffield, Yorkshire, contains a very good local collection. Its owner has offered it to the East Riding County Council for half its value, the value to be decided by two referees, one to be appointed by the Council and the other by Mr. Mortimer.

A COMMUNICATION was presented to the Senate on December 20th, from the Regents of the Smithsonian Institution suggesting the appointment of Mr. Richard Olney to fill the vacancy on the Board caused by the death of William Preston Johnson. Senator Hoar said he thought that it was the first time that the Regents had made such a suggestion. No action was taken by the Senate.

INVITATIONS for the next agricultural conference for the West Indies have been issued by the British Department of Agriculture. It is proposed to hold the conference at Barbadoes, and the dates fixed are Saturday the 6th, and Monday, the 8th of January next. The president, Dr. D. Morris will deliver the opening address. A new feature will be the presence of representatives of the leading agricultural societies in the West Indies. The list of subjects to be dealt with covers, practically, every branch of West Indian agriculture.

AT a meeting of the Fellows of the Royal Botanic Society, London, on December 8th, the chairman stated that it was very satisfactory to know that during the year 203 new Fellows had been elected, that number being higher than in any previous year since the foundation of the society. The largest number in other years was in 1850, when 186 Fellows were elected.

THE British Institution of Electrical Engineering held its eleventh annual dinner on December 6th. The President, Professor Sylvanus P. Thompson occupied the chair, and speeches were made by Mr. R. E. Crompton, General Sir R. Harrison, Sir W. C. Austen-Roberts, and Lord Kelvin.

Nature states that in connection with the British Institution of Electrical Engineers, a number of local centers are being established where papers will be read and discussed at the same time, or shortly after, their reading in London. In Cape Town these informal meetings have been held for some time past, and advance copies of the Institution's papers have been read at them. A meeting for the formation of a northeastern center was held recently at the Durham College of Science, and the Council have received a petition for the establishment of a similar organization in Dublin.

THE proprietors of the Marconi system of wireless telegraphy have offered the use of twenty sets of instruments to the Government on payment of $10,000 in the first instance and $10,000 a year for their use. Secretary Long has under consideration the advisability of asking Congress to make a special appropriation for the purpose.

AN institution on the lines of the Pasteur Institute, bearing the name Alfonso XIII., has been established at Madrid.

A DEPUTATION appeared before the Edinburgh Town Council on November 21st to urge the establishment of a zoological garden in that city.

The thirteenth International Medical Congress will be held at Paris from the 2d to 9th of August, 1900, in connection with the Paris Exposition. The work of the Congress is divided into five classes, each of which is sub-divided into from two to nine sections. The classes are, (1) biological sciences; (2) medical sciences; (3) surgical sciences; (4) obstetrics and gynecology, and, (5) public medicine. The biological sciences are divided into three sections (*a*) descriptive and comparative anatomy, (*b*) histology and embryology and (*c*) physiology and biological physics and chemistry. An American National Committee has been formed with Dr. William Osler as Chairman, and Dr. H. B. Jacobs (3 West Franklin street, Baltimore, Md.), as Secretary.

The third International Ornithological Congress will be held from the 26th to the 30th of June, 1900, as one of the series of official congresses of the Paris Exposition. The work of the congresses has been divided among five sections, as follows: (1) Systematic ornithology: classification; species; anatomy and embryogeny of birds; paleontology; (2) geographical distribution; appearance of rare species in certain districts; (3) biology; oölogy; (4) economic ornithology; (5) organization and working of the international ornithological committee.

From the 18th to the 23d of June an International Congress of Mining and Metallurgy will be held at Paris. The program proposes the following subjects for discussion: Mining, use of explosives in mines; use of electricity in mines; mining at great depths; labor-saving methods as applied to mining. Metallurgy: progress in metallurgy; progress in the metallurgy of iron and steel since 1899; application of electricity to metallurgy—(*a*) chemical, and (*b*) mechanical; progress in the metallurgy of gold; recent improvements in the dressing of minerals.

The Congresses of the Paris Exposition also include the first International Congress of Philosophy which will be held from the 2d to the 7th of August. There will be four classes: (1) general philosophy and metaphysics (2) ethics, (3) logic and (4) history of the sciences and history of philosophy. Under the third class especially a number of topics of interest to men of science are proposed for discussion.

An International Congress of Ethnology will be held in connection with the Exposition, on August 26 to September 1, 1900. There will be seven sections, dealing respectively with general ethnology, sociology and ethics; ethnographical psychology; religious sciences; linguistics and palæography; sciences, art, and industries; descriptive ethnography.

The *British Medical Journal* states that an attempt is being made to ascertain in which house in the Hotwell it was that Humphrey Davy discovered the anæsthetic powers of nitrous oxide. It is a well known fact that Davy was assistant to Dr. Beddoes, who had, in 1798, opened a house called the Pneumatic Institute for the treatment of disease, and more particularly phthisis by the inhalation of some of the then newly discovered gases, the Hotwell at Bristol being then a very popular watering place. Davy, it appears, was in the habit of administering the nitrous oxide to all comers at 2d. a dose, and from all accounts it was a popular amusement to go to the Institute and have the gas; the usual modern accompaniment of tooth drawing was omitted. The Institute appears from Stock's memoir of Dr. Beddoes to have been in Hope Square, but the common report puts it in Dowry Square. The Clinton Antiquarian Society, who are pursuing the investigation, hope to put a tablet on the house commemorating the fact that nitrous oxide was there found to have anæsthetic powers.

Professor Willis L. Moore, Chief of the U. S. Weather Bureau, has with the approval of the Secretary of Agriculture drafted a bill which has been introduced by the Hon. James W. Wadsworth in the House of Representatives. Professor Moore thus summarizes its chief features: It apportions appointments among Senators, Representatives, and Delegates, without regard to their political faith. It provides that candidates shall be nominated by the representatives of the people, under such rigid restrictions as to age, physical condition, and education as render it difficult, if not impossible, to effect the permanent appoint-

ment or the promotion of an unfit person. It prohibits the use of political or other influence to secure promotion or assignment, and I believe properly coördinates the prerogatives of Congress and the executive officers of the government in the matter of the appointment to and the control of the federal service. It places each employee strictly upon his merits and compels him to work out his own salvation, while the present law leaves all this to the caprice of the executive officer or the rules of a commission. It prohibits the removal of any employee for political reasons, and makes his tenure of office secure so long as his services are advantageous to the government, *and no longer.* Without one cent of expense to the Government, it provides for the separation from the public pay rolls of disabled or aged officials, and at the same time provides support in their hours of need.

Professor Wm. E. Hoyle, in the *Library Association Record* of November, speaks as follows of the *Concilium Bibliographicum* of Zurich and its work : "Zoologists are deeply indebted to Dr. Field for the self-sacrificing energy with which he has unstintingly devoted his time and his money to the advancement of the bibliography of their science, and it is not a little surprising that the Royal Society, which is maturing schemes for a card bibliography of the whole of science literature, should not have taken counsel with the only man who has had extensive practical experience of this kind of work. There is no doubt that when the admirable qualities of the catalogue become more widely known in England, more and more zoologists will subscribe to it and provide themselves with the cards bearing on the subjects of special value to them. Few private individuals will take the whole catalogue, unless they are prepared to spend time upon it and to provide ample space for it. It will be much more suitable for University and City libraries, the great storehouses of bibliographical information, to become subscribers and take full charge of all the cards. An attendant would then be entrusted with their arrangement and would be quickly able to direct any inquirers to the right part of the catalogue, which would be kept intact and securely fixed on rods like other card catalogues with which we are already familiar."

The class in Soil Physics at the University of Illinois as a part of their laboratory work, have undertaken a special study of samples of soil taken at different depths from two plats of ground. One of the plats has been subjected to a continuous cropping of corn for twenty-four years, and the other to a rotation of corn, oats, and oats and clover, for the same length of time, neither receiving any addition of fertilizers during the period, and all of the stalks and straw in case of the grain crops being each year removed from the plants. The results of the examination so far show that there has been a marked loss of humus in the soil which has been subjected to constant cropping of corn. This loss is greatest in the surface nine inches of the soil and amounts to more than 50 per cent. of the entire humus content as compared with that of the rotation. This loss of humus is evinced by a decrease in the producing capacity of the soil, which is now only one-third to one-half of that of average Illinois soils under ordinary farm conditions. It is also shown by a marked change in the color and physical texture of the upper layers of the soil, the soil being of a lighter color owing to the loss of organic and vegetable matter and to the ultimate soil particles being apparently reduced in size, which gives the soil an increased capillary power.

We learn from the London *Times* that with a view of making the law on the subject of wild bird protection uniform throughout the metropolitan police district, the London County Council intends to apply to the Home Secretary for the issue by him of a new order under the Wild Birds Protection Acts in regard to the County of London. Under the proposed new order the time during which the killing and taking of wild birds is prohibited by the Act of 1880 is extended so as to be from February 1st to August 31st. During the period from September 1st to January 31st the killing or taking of certain birds is also prohibited. These will, therefore, be protected during the whole year. The list of birds so protected includes the chaffinch, cuckoo, goldfinch, honey buzzard, gulls, kingfisher, lark, landrail, linnet, martin, swal-

low, nightingale, starling, swift, wren, magpie, garden warbler, owl, and redstart. A further effect of the order will be that all wild birds will be protected on Sundays during the whole year. The Parks Committee of the Council think this a most necessary step, as Sunday is the day on which the bird-catcher and cockney sportsman have the greatest opportunity of carrying on their operations. Another clause of the order adds the names of several birds to those in the schedule of the Act of 1880. The effect of this is to increase the penalty with regard thereto, as any person convicted in connection with the scheduled birds is liable under the Act of 1880 to a penalty in each case of £1, whilst for wild birds not in the schedule the penalty is by that Act fixed at 5s. in each case. The birds now to be added to the schedule of 1880 are the bearded tit, buzzard, chaffinch, honey buzzard, hobby, kestrel, magpie, martins, merlin, osprey, shrikes, swallow, swift, and wryneck. Under the last clause of the order it will be an offense to take or destroy the eggs of any of the birds set out in the schedule attached. Included in this schedule are the cuckoo, goldfinch, kingfisher, linnet, lark, magpie, martins, nightingale, starling, swallow, wren, redstart, and swift. The common house and hedge sparrow apparently receive no special protection under the order, except that provided by the close time from February 1st to August 31st.

DR. BURRILL, of the University of Illinois, has sent to Dr. Reynolds, Health Commissioner of Chicago, a report of bacteriological investigations upon the waters of the Illinois and Michigan canal and of the Illinois and Mississippi rivers, altogether extending from Chicago to St. Louis. The report covers the months of June, July, August, September, October, and November, and gives the monthly average number of bacteria found in a cubic centimeter of water taken from each of thirty-eight stations. The laboratory work was done by Mr. James A. Dewey. The figures, as tabulated, show that the whole stream has been, during the time, greatly polluted, but they also show that the water becomes rapidly purified as it flows along from the source of contamination. At Ottawa and LaSalle the number of bacteria has decreased from several million to a few thousand in a centimeter of water. Above Peoria the stream is nearly free from these organisms. Below this city the numbers rise again so as practically to equal those in the canal at Bridgeport. Farther down, the water again becomes gradually less infected, so that at the mouth of the Illinois there are less bacteria than occur in the waters of the Mississippi river.

WE learn from the London *Times* that at a recent meeting of the Departmental Committee on Preservatives and Coloring Matters in Food, Mr. J. Kellitt, of Liverpool, speaking on behalf of the Grocers' Federation, said that it was now absolutely necessary to use borax or boracic acid for ham, bacon, and butter, on account of the great demand for a mild-cured article. Borax, in his experience, was the most effective preservative he had known, especially for stopping fly-blow. Quite 75 per cent. of the hams and bacon sold in this country were treated with the preservative. After the bacon or ham had been prepared for cooking by the consumer most, if not all, of the borax had disappeared, so that in actual consumption the percentage of boracic acid present at the time the article was consumed must be small. Captain T. W. Sandes, who had started a creamery in county Kerry for the benefit of his tenants, said that he used generally to send to England butter that they called saltless—that is, butter that was cured with one pound of preservative to the hundredweight of butter. The preservative he used was boracic acid. The saltless but preserved butter was bound to be good butter, because impurities could be so easily detected in it, whereas the heavy salted butter need not be, as the salt, more or less, covered a few of the 'sins' in the butter. Mr. J. Wheeler Bennett, who appeared on behalf of the London Chamber of Commerce, said that the trade in Canadian hams had increased since 1889 from something like $300,000 to $1,800,000 in 1898, and this he attributed to the use of preservatives. If the treatment of hams by borax were prohibited, the whole of this gigantic trade from Canada would come to an end. There was a very large and increasing trade in Australian butter, and that trade hinged upon the use of borax, the

butter being washed in a solution of the preservative. The committee then adjourned.

UNIVERSITY AND EDUCATIONAL NEWS.

On December 20th, the University of Pennsylvania's free museum of science and art at Philadelphia, one of the late Dr. William Pepper's cherished hopes, was formally opened in the presence of several thousand people. Immediately following the presentation to the board of trustees of the museum, a bronze statue of the late Dr. Pepper, the gift of friends, was unveiled. The presentation speech was made by ex-Senator George F. Edmunds, in behalf of the Dr. Pepper testimonial committee. In connection with his address, Mr. Edmunds was delegated by Mrs. Frances Sergeant Pepper, the widow of Dr. Pepper, to present to the university trustees, as her memorial to the memory of her husband, a gift of $50,000 as a fund to carry on the work started by Dr. Pepper.

The Presidents of Harvard University, Columbia University, Johns Hopkins University, the University of Chicago, and the University of California have issued an invitation to sister institutions to a conference to be held in Washington some time in February, 1900, for the consideration of problems connected with Graduate work. The invitation says: "There is reason to believe that among other things the deliberations of such a conference as has been proposed will (1), result in a greater uniformity of the conditions under which students may become candidates for higher degrees in different American universities, thereby solving the question of migration, which has become an important issue with the Federation of Graduate Clubs; (2), raise the opinion entertained abroad of our own Doctor's degree; (3), raise the standard of our own weaker institutions.

The engineering laboratory for Stevens Institute, Hoboken, N. J., provided by a gift of $50,000 from Mr. Andrew Carnegie will be begun at once. The University of Wisconsin will also erect an engineering building, the Legislature having provided $100,000 for the purpose.

It is also announced that the Western Reserve University has received $12,000, from Mr. and Mrs. Samuel Mather for the purchase of books; Wabash College $5,000 from Mrs. W. R. Jones toward a residence for the president; and New York University $2,500 from Miss Anna M. Sandham for prizes in public speaking.

It is said that Mr. James M. Munyon will give $2,000,000 to found an industrial school for orphan girls in Philadelphia on the same general lines as Girard College.

Girton College, Cambridge, is being enlarged at a cost of £40,000.

The main building of Buchtel College, at Akron, O., including the laboratories, library and dormitories, was recently burned. The loss is $100,000, with $65,000 insurance.

Oxford University is planning the establishment of the degrees of Doctor of Letters and Doctor of Science, to be conferred for research work.

The Sheffield University College, England, has not succeeded in making arrangements for the occupation of the site of Wesley College, and it is now proposed to acquire a strip of land adjoining the Botanical Gardens on which to erect a new block of buildings.

Dr. F. W. Bancroft has been appointed instructor in physiology at the University of California.

Mr. Loye H. Miller, of the University of California, goes to Oahu College, Honolulu, H. J., as professor of chemistry and natural sciences.

Mr. J. H. Ridgway, brother of the ornithologist of the Smithsonian Institution, has been engaged as taxidermist at the University of Illinois and is now at work on the museum specimens. Mr. Ridgway has been connected with the National Museum, the University of Iowa, the Iowa Agricultural College, and the University of Ohio.

Professor Röntgen has finally decided to accept the call to the University of Munich.

Mr. A. W. W. Dale, M.A., fellow in classics of Trinity Hall, Cambridge, has been appointed Principal of University College, Liverpool, in place of Mr. Glazebrook, who has retired on his appointment to the office of Director of the National Physical Laboratory.

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